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# Rubber Research Institute of Ceylon

## Combined 3rd & 4th Quarterly Circulars for 1953

RUBBER RESEARCH INSTITUTE CEYLON

March, 1954

# CONTENTS

**Rubber Conference held on 16th November, 1953.**

# FOREWORD

A Rubber Conference organised by the Rubber Research Institute o Ceylon was held at the Planters' Association Head Quarters, Colombo, on 16th November 1953. This was the third of its kind, the first two having been held in 1938 and 1940.

The Conference was opened by the Hon'ble Mr. J. R. Jayewardena, Minister of Agriculture & Food, and associated with him on the platform were Mr. W. P. H. Dias, J.P., Chairman of the Rubber Research Board, and Dr. H. E. Young, Director, Rubber Research Institute.

Seven papers were given. These were circulated in advance to all those —about 375 in number—who had notified their intention of being present. A summary of each paper was read by the authors as an introduction to the discussion, with lantern slides in illustration of diagrams etc. The papers and discussions are reproduced in this issue of the Quarterly Circular as a permanent record of the proceedings.

The Conference was generally voted to be highly successful as evidenced by the attendance to the full capacity of the hall and the interest shown in the discussions.

The thanks of the Institute are due to the Planters' Association of Ceylon for the use of its hall and the assistance rendered in connection with the arrangements for the Conference.

# RUBBER CONFERENCE HELD ON 16th NOVEMBER, 1953

### Mr. W. P. H. Dias, J.P.
### Chairman, Rubber Research Board

Hon. Minister and Gentlemen,

ON behalf of the Board of Directors and Staff of the Rubber Research Institute of Ceylon, I welcome you all to participate in the conference we are holding today.

I am particularly happy to welcome our newly appointed Minister of Agriculture and Food, the Hon. Mr. J. R. Jayewardene, who has kindly consented to address the conference at short notice. Mr. Jayewardene has left an important Ministry for a still more important one, his initiative and drive measure up to his own stature, and I am sure that we who are assembled here can assure him that in the tasks which lie ahead, we shall not hesitate to put our shoulders to the wheel and push with all our might. You, Sir, have assumed the office of the Minister of Agriculture and Food at a most crucial period in the Rubber Industry, not only in Ceylon but also throughout the natural rubber producing areas of South East Asia. We are being squeezed by a preponderance of accumulated stocks in consuming countries, by the production of synthetic rubber in the United States of America and by the sale of it at a price which is by no means a correctly computed figure in relation to its cost. Had the enormous output of the synthetic rubber G-R-S in the United States been handed over to private enterprise, I have little doubt that the cost of it would have exceeded 23 dollar cents.

The London conference of the Management Committee of the International Rubber Study Group has agreed that recent price developments are placing the natural rubber Industry in a serious position. Their estimate of surplus stocks by the end of 1953 has been put down at 169,000 long tons. Their suggestions are that re-planting programmes be accelerated, the creation of a new natural rubber stock, and action by the Government of the United States to increase the price of G-R-S, to re-examine its practices in stockpile rotation and to revoke a directive relating to mandatory consumption requirements for synthetic rubber. If the Government of the United States takes such action, realising as it should do that the natural rubber producing areas are fighting for self preservation and self determination in newly won political fields, the pressure on the industry must surely ease. We have to maintain a just and reasonable wage for the workers in the industry, a profitable return to the small holder and at the same time remember that however large the capital construction of a Company may be, there also are a large number of small share-holders some of whom may have invested their life's savings in the industry. We cannot exist without a fair and reasonable price for our rubber.

We have recently seen what effect the prices obtained for our primary produce has on the economy of our country. A favourable trade balance in 1950 and 1951 has swung violently to the debit side in 1952 and the country's budget has caused much concern to us all. Rubber is the commodity which has shown a steady downward trend without any immediate hope of recovery.

Since the beginning of this year with the confirmation of a contract between the Government of Ceylon and the People's Republic of China, a subsidy scheme for the replantation of rubber had been under contemplation and reached a stage of finality with the appointment of a Rubber Rehabilitation Board with the Rubber Controller as its Chairman. We now have Ordinance No. 36 of 1953 "The Rubber Replanting Subsidy Act," bringing the Scheme within the law.

In my opinion the subsidy scheme has been the greatest boon to the rubber industry of this country since rubber was first planted. Those of us who have planted rubber all our lives have seen the decline in yields and increase in costs and have viewed with alarm, amidst the rejoicing in 1950 and 1951, the decline in the industry. Questions have been asked as to whether any industry should be subsidised in a period of stringency, and our reply is that the Rubber Replanting Subsidy Scheme is one reducing some of the profits of the sheet rubber producers in the interest of the rubber industry as a whole and for the benefit of the country.

I need not ask you, Gentlemen, to subscribe to the scheme because applications have poured upon us like a mighty flood. The applications we have received reveal the plight of the industry and I sincerely hope that what can be released by way of a subsidy will not limit the extent of the replantations. Rather let me hope that the subsidy will be received as a welcome gift and encourage those bent on replanting to draw on their savings and improve their assets, so that we may continue to produce our rubber and maintain the country's exports at the same high level in bad times as well as in periods of boom prices.

The Rubber Research Institute has a great part to play in the years which lie immediately ahead of us. Through years of persistent endeavour, by the accumulation and dissemination of knowledge in scientific fields, by the contributions made by a band of conscientious and industrious officers, the Institute, now ably directed by Dr. H. E. Young a person of outstanding talent and genial disposition, is ready and willing to play its part. We could not have hoped for, nor could we have found, a better collection of officers to work today in the Rubber Research Institute. I have worked with them as Chairman of the Board which directs their activities, and they are ready to help those who wish to improve their estates or small holdings on the fields or in the factory.

You, Sir, have visited the Institute and also climbed up to the highest point at Hedigalla, which one day could be the greatest contribution Ceylon has made to the natural rubber industry of the world. The very essence of the work of the Rubber Research Institute is to be found at Hedigalla and it may well be that the most prolific of high yielding clones lie hidden among the multiplicity of clones now growing there. I hope that this is so, and if it is, it will be a worthy tribute to those who have served the Institute.

I shall not delay you much longer, we have a long programme for one day, and I hope that when evening comes you Gentlemen can draw your travelling charges from your Agents with no qualm of conscience. I hope you will not spend it all in quenching your thirst after what looks like being a hot day.

On your behalf I wish to thank all those who have submitted carefully thought out and well prepared papers for discussion. I know how difficult it is to find time during moments of leisure to sit down to another job, but they

have overcome such difficulties and we are grateful. I would ask you kindly to be brief and direct in the questions put to the speakers throughout the day.

Among those visitors present we have Dr. A. Newsam, Ph.D., Head of the Pathological Division of the Rubber Research Institute of Malaya, who has come from Malaya as a guest speaker and will deliver a paper later in the day. We hope Dr. Newsam has a pleasant and useful stay in Ceylon and we greatly appreciate the goodwill of the Rubber Research Institute of Malaya in allowing Dr. Newsam to visit us.

I must also welcome:

The Chairman and Officers of the Planters' Association of Ceylon
The Chairman and Officers of the Low Country Products' Association
The Director of Agriculture and his Officers.
Mr. C. E. P. Jayasuriya, Director of Commerce
Mr. B. Mahadeva, Rubber Controller
Mr. H. Jinadasa, Rubber Commissioner
Dr. Sunderalingam, Chief Chemist, Dept. of Industries
The Director and Officers of the Tea Research Institute
The Director and Officers of the Coconut Research Institute
Mr. Kaimal, Chairman, Rubber Production Board, South India

I now ask you, Sir, to declare open this 3rd Rubber Conference.

**Speech made by the Hon. Mr. J. R. Jayewardene, Minister of Agriculture & Food, on the occasion of the opening of the Third Ceylon Rubber Conference on Monday, 16th November 1953 at 9-30 a.m**

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Over a decade has passed since the Rubber Research Institute held its last Conference. This decade has probably been the most eventful in the history of the rubber industry. Not only has the total world consumption of rubber increased at an unprecedented rate—it has more than doubled itself during this short period from one million tons in 1940 to an estimated 2.5 million tons this year—but a vast and highly efficient synthetic rubber industry has been built up during the same period to challenge the hitherto undisputed supremacy of natural rubber. When your last Conference was held in 1940, synthetic rubber was an insignificant factor in the rubber markets of the world. The United States which, as you know, is by far the world's biggest rubber consumer, produced hardly 8,000 tons of synthetic rubber at the time. Her present production of synthetic is a hundred times as large, amounting last year (1952) to 800,000 tons. Synthetic rubber now accounts for over one-third of all the rubber used in the world, and in the United States the proportion is even higher, being well over one-half of the total rubber consumed.

How will the natural rubber industry face up to its most urgent problem —the challenge of synthetics? Until recently, the competition between natural rubber and synthetic was not an equal one. The scales were weighted heavily in favour of synthetic rubber. This was due to a variety of causes, particularly

to the substantial measure of protection which the United States Government gave the synthetic rubber industry during and after the Second World War. Until recently, manufacturers in the United States were compelled by law to use a high percentage of synthetic rubber in all rubber goods produced by them. Secondly, the import of natural rubber into the United States by private firms was prohibited, all imports being made by a Government Agency. And finally the United States Government was the sole producer of synthetic rubber in the country, and therefore controlled the volume and price of synthetic rubber released on to the market. The first two of these restrictions were fortunately relaxed last year, but Government ownership of synthetic rubber plants continues. Even this restriction is due to come to an end shortly. On August 7th this year, the United States Congress passed an Act authorising the sale of the Government-owned synthetic facilities to private enterprise. The actual sale will probably take place about the end of 1954 or early in 1955. When this happens, there will be, for the first time, completely fair and free competition between natural and synthetic rubber in the rubber markets of the world. As long as Government ownership continues, the Government-owned synthetic industry pays no interest on its capital; it spends nothing on the advertisement of its product, and its immense research programme is separately financed from military votes. No private company could afford to sell synthetic rubber at its present price of 23 dollar cents, or Rs. 1.20 a lb. When the transfer of the industry to private hands is completed and synthetic rubber is sold at its true commercial price in an absolutely free market, natural and synthetic rubber alike will have to submit themselves to the only true ultimate test—the judgment of the market place.

How will natural rubber fare when this testing time comes? There are two views on this subject. One school of thought takes a very gloomy view. Natural rubber, it says, is a fixed material whose properties are determined by its natural origin and traditional methods of production. Synthetic materials will be evolved whose properties will increasingly cover the range associated with natural rubber, and the natural rubber industry will be subject to greater and greater encroachment on its traditional territory and with ultimate extinction. The other school of thought, to which the majority of experts are inclined, is a far more cheerful one. In their view, natural rubber, like synthetic rubber, is a chemical raw material capable of control and modification. By proper selection and breeding, new high-yielding strains of natural rubber can be evolved. By properly directed research, new and cheaper manufacturing methods can be developed and better types of natural rubber produced and marketed, which will be able to compete effectively with synthetic rubber. If this view is correct (and I have no doubt that it is) then *research* is the key to the future prosperity of the natural rubber industry, and organisations like the *Rubber Research Institute* have an even more important part to play in the future of the industry than they have played in the past. As I see it, if natural rubber is to compete effectively with synthetics in the future, the objectives of Research Institutes like yours should be primarily—

(i) to develop new varieties of high-yielding rubber so that as large an area as possible of worn-out old seedling rubber may be replanted with these high-yielding strains, thus slashing the cost of production of natural rubber and enabling it to compete more effectively with synthetics.

(ii) to improve yields by controlling rubber-diseases, particularly oidium, and developing disease-resistant strains; and

(iii) to improve the present unsatisfactory methods of grading, classifying and packing natural rubber so that it would be as attractive to consumers as the better packaged and more accurately classified synthetic product.

I propose to deal briefly with each of these matters in turn.

### (i) Replanting with high-yielding strains

No praise is too high for the long and sustained efforts made by the Rubber Research Organisations in Malaya, Indonesia and Ceylon to breed ever-improved varieties of high-yielding rubber. We have come a long way since Dr. Cramer carried out his pioneer budgrafting experiments in Indonesia in 1917. Today we have developed high-yielding strains, both budgrafts and clonal seedlings, with yields close upon 2,000 lbs. per acre, as compared with the average of 300 to 400 lbs. for old seedling rubber. Unfortunately, we in Ceylon, unlike planters in other rubber-producing countries, have been slow to benefit from the fruits of this research. Malaya has replanted over 600,000 acres with high-yielding clones and Indonesia about 550,000 acres, compared with barely 60,000 acres in Ceylon. As against this, it is estimated that over 200,000 *acres*, or nearly one third of Ceylon's entire rubber acreage, has been rendered hopelessly uneconomic by the intensive slaughter-tapping which it suffered during and after the Second World War. The greater part of this rubber is well past its prime, being over 35 years old, and unless immediate steps are taken to uproot it and replace it with high-yielding strains, it will not be long before Ceylon is wiped off the rubber map of the World.

These facts were forcefully brought out by the Whitelaw-Perera Rubber Commission, whose Report, published in 1947, shocked the Ceylon rubber industry out of its complacency, by stating that unless the industry embarked on a vigorous and sustained replanting programme, it was doomed to early extinction. I would like to take this opportunity of paying a tribute to Mr. E. W. Whitelaw, one of the two members of the Rubber Commission, whose untimely death was announced from London only a few days ago. The Ceylon rubber industry owes a deep debt of gratitude to this great planter, and the Ceylon Government wishes to place on record its appreciation of his invaluable services to the industry.

Although nearly 6 years have passed since the Whitelaw-Perera Report was published, it was only a few months ago that the Ceylon Government launched its Rubber Rehabilitation Programme. This delay was due entirely to the continued instability in the price of rubber since the Report was published in 1947. Rubber slumped to under 50 cents a lb. in 1948, then shot up to Rs. 3.30 a lb. in 1951, and slumped again to under one Rupee at the end of last year. It was clearly impossible to work out a satisfactory Rehabilitation Scheme in these circumstances. Fortunately, the conclusion of the China Trade Pact stabilised the price of our rubber from the beginning of this year, and gave the Ceylon rubber industry a golden opportunity, which may never come again, to set its house in order.

With the proceeds of the cess recovered on exports of rubber to China, it is hoped to replant about 13,000 *acres* a year, or about 65,000 *acres* over the next five-year period during which the Scheme will be in operation. When this area comes into bearing, Ceylon's rubber production can confidently be expected to increase by 25%.

Fears were expressed when the Scheme was originally mooted that not many persons would participate in the Scheme, as most rubber owners, particularly small owners, would be reluctant to sacrifice even the small income which they now receive from their moribund rubber lands until the new rubber comes into bearing. These fears have proved groundless. The response to the Scheme has been most encouraging. The Rubber Controller, who is in charge of the administration of the Scheme, informs me that permits to replant nearly 8,000 *acres* in 1953 have been issued by him. This entire area has already been inspected by Visiting Agents. The replanting of most of it has already been completed and work on the remainder is now in progress.

As the Rehabilitation Scheme was launched only about the middle of this year, it was not possible to replant more than 8,000 *acres* in 1953, as against the annual target of 13,000 acres a year under the Scheme. The balance monies will be carried forward to 1954, and it should be possible to replant at least 18,000 *acres* under the Scheme next year. Over 6,000 applications have been received for 1954 replanting and these are now being examined. It should be possible to issue the 1954 Replanting Permits by about January next year.

I hope that it will be possible to replant next year a much higher acreage of small-holdings than was possible in 1953. Most small-holders (unlike the owners of large estates )did not have their own nurseries to provide high-grade planting material for replanting their lands in 1953. This difficulty will not exist in 1954. Large Government nurseries have been opened up in all the rubber growing districts of the Island which will be able to supply all the planting material required by small-holders in 1954. With this planting material, it is hoped to increase the extent of small-holdings replanted under the Scheme from about 600 acres this year to over 4,000 acres in 1954.

Many of you in this hall today have been appointed Visiting Agents under the Replanting Scheme. The Rubber Controller informs me that it was decided not to employ an army of poorly-paid Inspectors to inspect and report on the lands replanted under the Scheme. This would inevitably have led to widespread bribery and corruption. Instead, panels of experienced planters (usually Superintendents of rubber estates over 300 acres in extent) have been appointed for each D.R.O's Division, and the instalments of the subsidy will be paid primarily on their reports. I need not emphasize how much the entire success of this Scheme depends on your co-operation. But I would like to make a special appeal to you regarding your visits to small-holdings being replanted under the Scheme. Small-holders require your guidance and assistance for the proper replanting of their land, and I appeal to you, on your visits to their holdings, to give them every assistance in your power.

**(ii) Control of rubber diseases.**

The absence, until recent months, of a vigorous replanting programme has not been the only cause of the deterioration of Ceylon's rubber industry. The ravages of oidium have been a powerful contributory cause. Oidium was first noticed in Ceylon in a very mild form in 1925. Now it has spread to practically every rubber-growing district and there is hardly an estate in Ceylon which is completely free from infection. What makes the position worse is that, although the disease is not completely unknown in Malaya and Indonesia, it appears in those countries in a much less virulent form and its incidence is so restricted in those countries that it hardly constitutes a menace to the industry.

Fortunately, the excellent work of the Rubber Research Institute has enabled us to keep the disease in check. The pioneer work on oidium-control by Mr. R. K. S. Murray has recently been followed up vigorously by other officers of the Institute and we have now developed efficient techniques for controlling the disease by sulphur-dusting. Unfortunately, in 1951, the United States, hitherto our principal supplier of dusting sulphur, imposed a ban on the export of sulphur to Ceylon. As a result, practically no sulphur was imported into Ceylon for the 1951-52 dusting season. The position improved in the 1952-53 dusting season, however, as a result of certain measures taken by the Ministry of Agriculture, and whereas hardly 400 *tons* of sulphur were imported into the Island for the 1951-52 dusting season, over 4,000 *tons* were imported for this year's dusting. The reports reaching me indicate that Ceylon's rubber has benefitted greatly from this liberal application of sulphur, and that many valuable areas of budded rubber carry the best foliage seen for many years.

Early next year, a new and important experiment is to be carried out in the sphere of oidium-control. Hitherto, oidium has been controlled by the application of *dry sulphur* dusted on to the leaves of rubber trees from small portable dusting machines. It has been known for some time that if, instead of dusting dry sulphur, *wet sulphur* is sprayed on the foliage, this would afford more complete protection against oidium.

There are practical difficulties, however, which make the general adoption of wet spraying difficult. A much larger and more expensive machine is required than for dusting with dry sulphur and, what is even more important, this larger machine cannot be moved from place to place on most estates without the construction of an elaborate net-work of internal roads, the cost of which would be prohibitive.

It has been suggested that this difficulty could be overcome by the wet-spraying of sulphur *from the air*. Representatives of a British firm of international repute, which has undertaken the large-scale protection of various crops against diseases and insects in many parts of the world, have expressed the view that the aerial spraying of sulphur from helicopter aircraft is feasible. As an experiment, about two or three thousand acres of high-yielding rubber is to be sprayed from the air during the next wintering season (January to March 1954) in order to obtain more definite data on the costs and the degree of control achieved. My Ministry has authorised the Rubber Controller to release the sum of Rs. 100,000 to meet part of the cost of this experiment. I confidently expect that this experiment will pay handsome dividends in the future and ensure that Ceylon's rubber plantations, including those which are now being replanted under the Rubber Replanting Subsidy Scheme, will be fully protected from the ravages of oidium.

### (iii) Improved packing and grading of rubber

In concentrating our attention on increasing the production of Ceylon rubber by extensive replanting and oidium-control, we must not lose sight of the equal importance of improving our packing, grading and marketing methods. The Rubber Manufacturers' Association of America, speaking for the consuming industry, said recently that "the future success of natural rubber rests on the ability of producers to develop a clean, uniform product, properly graded and packaged; improvements in this direction are long overdue." This is not a novel theme for the R.M.A.—this plea for greater producer effort to improve marketing practices. The only difference from the

past is that the consuming industry is now in a stronger position to make the producing industry take heed. Synthetics are being improved and, according to the R.M.A., are already "vastly superior to natural rubber at least as far as cleanliness, uniformity and packing go." In this field, too, Malaya is far ahead of Ceylon. Malaya has recently introduced a "Rubber Shipping and Packing Control Ordinance" under which all rubber packed in Malaya and shipped overseas is subject to control by the Malayan Rubber Export Registration Board. Any serious complaints about the grading and quality of Malayan rubber from overseas buyers will be dealt with by the Board, which will have the power to withdraw shipping and packing licences. The introduction of similar legislation in Ceylon is now being considered by my Ministry in consultation with the Ministry of Commerce.

More important still, Malaya, Indonesia and other rubber producing countries have recently been developing what is called "*Technically Classified rubber*". Natural rubber is, as you are aware, now graded purely by appearance—i.e. on cleanliness, colour, etc. But these criteria are far less important to consumers than the actual physical characteristics of the rubber such as elasticity, rate of vulcanisation, etc. Rubber classified in accordance with these characteristics is called "technically classified rubber". This classification ensures that the manufacturer obtains a homogeneous product, instead of one with variable properties, and thus to a large extent equalises the position of natural and synthetic rubber in this respect. Last year, Malaya and Indo-China together exported over 20,000 tons of technically-classified rubber, and this year exports are likely to be even higher. It is significant that this rubber fetched higher prices on the world's markets than ordinary rubber. I understand that the Rubber Research Institute of Ceylon is now doing some work in the field of technical classification and I am glad that one of the papers to be discussed at this Conference deals with this subject. I hope it will not be long before Ceylon exports its first consignment of technically-classified rubber. Unless we do so soon, Ceylon rubber will before long be quoted at a discount on the world's markets.

The Rubber Research Institute of Ceylon, is I believe, the oldest of the rubber research organisations in the East, its precursor having been established as far back as 1909. The Rubber Research Institutes farther East (in Malaya and Indonesia) have, however, long since outstripped our Institute in the size of their staffs and the quality of their equipment. In spite of chronic shortage of staff and equipment, however, our Rubber Research Institute has done and continues to do magnificent work in furtherance of the interests of the Celyon rubber industry. I had the opportunity of seeing its work at first hand when I visited the Institute a few weeks ago, and I am sure every one of you will agree with me when I express the deep gratitude of the industry and of the country as a whole for the splendid work of the Institute.

# DIRECTOR'S ADDRESS TO CONFERENCE

## The Institute

BY

**H. E. Young—Director**

As is usual at such a Conference it is the Director's lot to speak in general terms of the work of the Institute. This subject is a long one and is described in detail in our Quarterly Journals and Annual Reports and I am sure you do not wish me to enumerate all these details once more, particularly as the history and work of this Institute harks back to the year 1910 when the first meeting of the Executive Committee was held in Colombo on 19th October.

At that time there was only one scientific officer who was working on Hanwella Estate. He later transferred to Gikiyanakande Estate and the headquarters with the growth of staff and funds moved to Peradeniya then to Culloden Estate and finally to Dartonfield. I say finally because it would seem impracticable to move elsewhere now we have achieved permanent laboratories, a factory, housing and 1336 acres of land in the neighbourhood.

In regard to staff we are now better off than at any previous period of our history. The same remark applies to our essential scientific equipment, factory machinery and also of course to the acreage of rubber land under experiments both on our own lands and on commercial estates where a number of manurial, disease control and clone trial experiments have been arranged with the co-operation of the owners.

The chief aim of the rubber producing industry, as with other industries where competition is keen, is to reduce the cost of production of the product and to improve the product to make it more attractive to the user or potential user.

There are several ways of reducing costs of production in any undertaking among which the chief one is an increase of production of the product per man and per acre which gives an increase in return on capital invested. Another way is to reduce the cost of labour by reducing wages. This latter method however is not in our sphere of investigation.

The increase of production per man per acre can be attempted in the case of rubber by obtaining a better yield from existing plantations by means of disease control, correct manuring practices, better harvesting methods, i.e. correct tapping systems, and a rationalization of the transport in the field and from field to factory.

These aspects are all being considered and have undergone considerable improvement. The other aspect is the provision of higher yielding planting material which will normally produce a much higher crop per acre. In addition there is the development of disease resistant clones which will not suffer loss of crop due to disease attacks or need the expense of control measures. Following the initial selection and proving by the Institute of naturally occurring high yielding trees on estates and their subsequent development into proved clones such as MK. 3/2, Wagga. 6278, Hillcroft 28 & 25 and the NAB. series,

a large breeding programme was commenced at the Institute in the late 1930, and during the 1940's, and we have again during the last year or two with the acquisition of sufficient staff continued this programme. The first results of this venture are beginning to bear fruit and we have a number of clones resulting from hand pollinations which in small scale trials have shown remarkably good results. These are being put out on large scale trials as preliminary tapping results become available. Budwood of some of the first of these will be available to the industry in 1954. Hand in hand with this is the introduction of new material from other countries for preliminary trial here and distribute to the industry. In this way we are at present testing material developed in Indo China, Malaya and Indonesia.

Breeding for disease resistance to *Oidium heveae* is well under way and we already have clones formed from seedlings of South American Leaf Blight resistant trees from South America in our possession for further development.

The Institute keeps a standard budwood nursery of guaranteed material of all available good clones for distribution to the industry as required.

It is felt that one of the greatest advances we can make in production per acre is by the provision of improved material. The Institute is doing its best in this avenue with the staff available but is unable to extend this work as we are now, with a full staff and large commitments on field work, using up our income.

In disease control most of our energies are being devoted to improvement in the methods of control of Oidium and we are making definite advances in improving the present method of control by dusting with sulphur as well as by other methods such as wet spraying. The aerial spraying trial arranged in co-operation with Messrs. Pest Control and the Planters' Association of Ceylon will be of particular interest in the coming season.

As regards the preparation for attack by South American Leaf Blight, which disease as you know is much more serious than Oidium, which has up to the present prevented the development of an effective rubber plantation industry in South America, we are working in co-operation with the Rubber Research Institute of Malaya. Arrangements have been made to obtain definite blight resistant material from the Americas. This material is now in Malaya where it has been received by way of quarantine stations in Florida and England.

Ceylon will receive its material from Malaya next year we hope. All these elaborate precautions are necessary to prevent the entry of this disease to the East. Such an event could mean quick ruin to the whole industry. We have however to make preparations for the possible accidental entry of this disease on aeroplane wheels etc. by provision of resistant material for inclusion in our own breeding programme and for top budding and general planting purposes. We are doing all that is possible in this aspect. It would however I consider be of advantage to the whole Eastern rubber industry if the countries concerned were to co-operate in establishing a station in the South American Leaf Blight region where breeding and selection of high yielding resistant material could be carried out as quickly as possible, so that this material might be supplied to the East to ensure the survival of the industry.

It is far easier to breed and test material for disease resistance where the disease actually occurs. We cannot risk bringing the disease to the East for such testing purposes. Our first work after the establishment of this material

in Ceylon will be to test it for Oidium resistance. If it proves resistant to Oidium as well as Dothidella its widespread use in Ceylon will become an obvious procedure.

An officer of the Staff of the Mycology Department, which handles disease investigations, has recently returned after a two years successful study course in plant pathology at Mc.Gill University in Canada.

The Smallholdings Department of the Institute is fostering better production on smallholdings and small estates by advice on all aspects of planting and harvesting and by provision of the best available material for planting.

The Chemical Department is looking after the manufacturing side of production and is just completing a survey in regard to the technical classification of Ceylon's Rubber which is a classification based on actual manufacturing properties of the Rubber and not on mere visual appearance which has little to do with such properties. Technical grading of rubber is growing in Malaya, Indonesia and Indo China and has a definite user appeal in that the buyer is able to buy the type of rubber required for his processing. This classification offsets one of the main present advantages of synthetic rubber i.e. that it does not vary in the batch as does natural rubber and factory adjustments have not to be frequently made as with the natural article.

With our new experimetal smoke house, which is being equipped for many possible alterations in procedure, we hope next year to provide definite information concerning the best methods of manufacturing smoked sheet. In addition with the new variable geared rubber mills now being installed we intend to undertake investigation of crepe rubber manufacturing methods.

Factory effluent disposal is also being investigated at present.

The Agronomy Department is busy with its manurial trials on our own and commercial estates and is also investigating suspected deficiencies in macro and micro elements with the aid of the spectrophotometer which has been installed.

Weed control with modern weedicides are also being investigated. An officer of this department is at present undergoing a course of studies at the Waite Agricultural Research Institute to better fit him for work in Ceylon in the future.

In fact all this means that as many aspects of the production of rubber in Ceylon are being worked upon as the extent of our resources allows.

When it is considered that last year alone over 12,000 letters were written in answer to a similar number arriving at the Institute, it will be realised to some extent the amount of time consumed in advisory duties by the staff. Indeed there has been such a demand for advisory services by correspondence, visits and demonstrations that the actual progress of research is being seriously interfered with and the time has come when it is necessary to consider the ways and means of providing an advisory service which will operate without further deterioration of technical advancement. Such a service is however at present outside our financial reach.

Advisory services also include our Quarterly Journal, Annual Reports, lectures and questions at meetings and Advisory Leaflets in English and Sinhalese.

I feel I can without embarrassment state that the industry is getting its full money value for the cess being devoted to the Institute and also can say that if additional large scale work is required by the industry it can only be carried out by the provision of extra funds. It is in the hands of the industry to decide whether it is satisfied with the present scale of opearations or not.

In this address I have only been able to touch on a few of the activities of the Institute, a number of which and others will be discussed in more detail by the later speakers in their papers which are to follow and I will conclude my remarks with the hope that the industry does not find us failing within the limits of our powers. If it is considered the Institute is failing in any way I can only request that we be informed of our failings where they are thought to occur so that we may if possible rectify matters. I would also like to thank the Ministry of Agriculture & Food, other Government Departments, the planting Associations and Commercial interests as well the Planters themselves for their whole hearted co-operation with us in the many instances where more than normal co-operation in our work has been required.

Our thanks are also due to the Rubber Research Institute of Malaya for its ready co-operation with us in our work an instance of which is the presence of Dr. Newsman with us here today.

## Speech by Mr. S. Pathmanathan, Chairman, Low Country Products Association

Mr. Chairman, The Hon'ble the Minister and Gentlemen.

We are fully conscious of the fact that the Rubber Research Institute has done a magnificient job for the rubber industry.

You, Sir, pointed out to us that the most urgent problem the natural rubber industry has to face is the challenge of synthetic. If we are to face the competitive problem of synthetic rubber we must do our utmost to see that everything is done for the Rubber Research Institute. As pointed out today by the Director some of the important work of research has been interfered with as a result of excessive demand on Research Officers for advisory services. We fully realize that research workers must be given every encouragement and opportunity to extend their work. The problem of advisory work is as equally important to us as research work and I feel that research must be made available to the industry. We fully realize that every cent spent is of absolute value to us and I take this opportunity of inviting the Director and Members of the Staff to draw up a plan for consideration which will allow a balanced programme for research and extension without causing undue hindrance to research projects in order that the industry may obtain the full benefits of both.

# REPLANTING AND CONTROL OF POWDERY MILDEW

BY

**Ir J. H. Van Emden, Mycologist**

Although in the larger part of the Ceylon rubber area Hevea does not suffer greatly from powdery mildew until the trees have reached maturity, the Oidium problem should not be overlooked at the stage of replanting. Choice of planting material will greatly influence the incidence of the disease in later years and the planting system adopted may prove to have a far reaching effect on the possibility of disease control by application of fungicides and the cost thereof.

## 1. CHOICE OF PLANTING MATERIAL

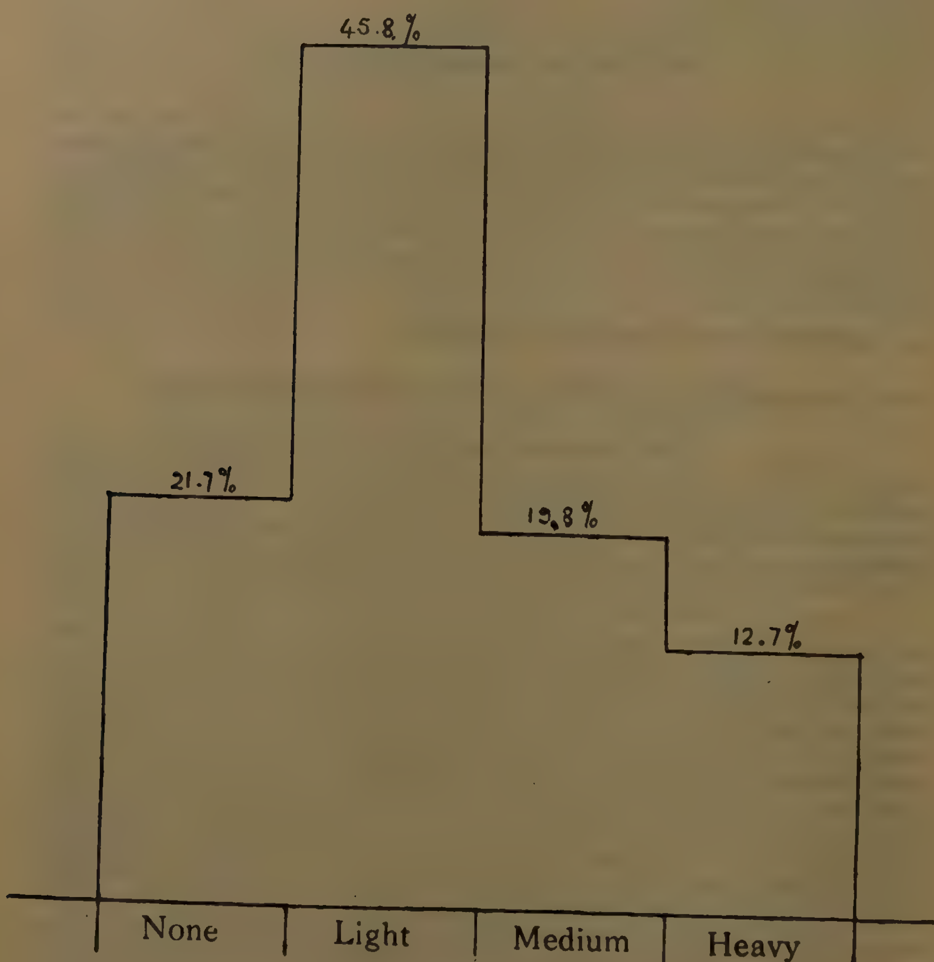
### 1.1. Susceptibility of different kinds of planting material.

It is already common knowledge that there is a wide variation in susceptibility to Oidium. For example Tj.1 is known as a very sensitive clone whereas LCB 870 is considered highly resistant to leaf disease. It would be useful to know what is the position with regard to the other clones and to clonal seedlings. Methods for testing the susceptibility of an individual plant have not yet been developed and for the time being, direct observation of mature trees seems to be the most reliable method of assessing the susceptibility of any kind of planting material. It is however a well known fact that incidence of Oidium on a particular tree is highly dependent on environmental factors. If a tree winters early in the season, it escapes mildew attack, probably due to the fact that there is not yet enough inoculum about to cause a heavy infection. The same may apply for a whole field. Hence observation of one field during one year cannot be considered reliable evidence as to the degree of sensitivity of the clone concerned. In this connection I want to recall the phenomenon often observed that a field which suffers badly from Oidium in one year may, due to its exhausted condition, winter abnormally early the next year and thereby escape Oidium. Observations in two consecutive years may lead to very different conclusions. The only way to obtain a reliable indication as to the relative susceptibility of any kind of planting material is to collect a large number of data from as many localities, and over as many years, as possible and to analyse those very carefully. In April 1953 a questionnaire was sent to all rubber estates, in which questions were asked as to the incidence of Oidium, methods of control adopted, rainfall etc.

Although a fair number of carefully completed returns were received, there were also a considerable number which did not give the required information and especially the superintendents who had not done any sulphur dusting seem to have been under the impression that data from their estates were of no interest and from that section very little information was obtained. Hence the analysis of data which will be dealt with in this paper, only refers to estates where sulphur dusting was carried out. This point should not be overlooked.

The first question to be dealt with is: what was the incidence of Oidium on estates where sulphur dusting was done. The graph reproduced in fig. 1. gives a frequency distribution of all reports received on all clearings.

Fig. 1.




On the horizontal axis the degree of intensity of the mildew is marked as "none", "light", "medium", or "heavy". On the vertical axis the frequency is indicated in which each of these gradations occurred as a percentage of all reports. We see that approximately 22% of the returns reported "no oidium" 46% reported light Oidium, 20% reported medium and 13% reported heavy Oidium. If we assume that a light attack will not interfere with the normal functioning of the trees, we see that in this year two thirds of the rubber clearings where sulphur dusting was carried out, did not suffer from powdery mildew.

Before proceeding with the analysis, I want to make it clear that I do not consider the above to be proof of the efficiency of sulphur dusting as a remedy

against Oidium. That is quite a different point. The wording of the conclusion only indicates that we are dealing with an analysis of sulphur dusted areas.

The total number of reports of which a frequency distribution was given in figure 1 is made up of reports on various clones. Table I shows the analysis for all types of planting material reported on.

TABLE I

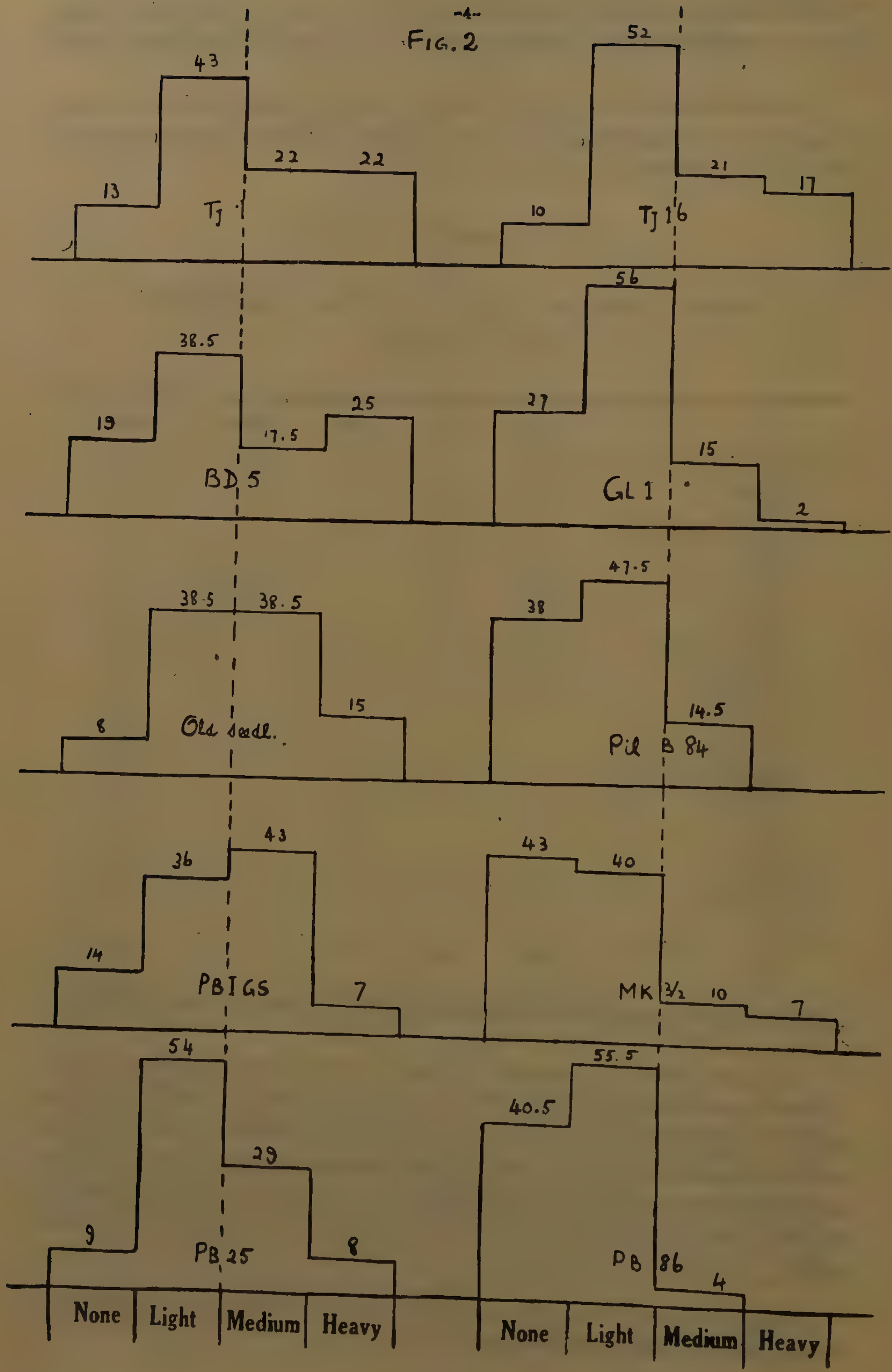
*Summary of reports on the incidence of Oidium in sulphur dusted fields in* 1952/53

| | None | Light | Medium | Heavy | Total |
|---|---|---|---|---|---|
| Tj. 1 | 16 | 51 | 26 | 26 | 119 |
| PB. 86 | 30 | 41 | 3 | — | 74 |
| Tj. 16 | 6 | 32 | 13 | 11 | 62 |
| Unselected Seedlings | 5 | 23 | 23 | 9 | 60 |
| BD. 5 | 10 | 20 | 9 | 13 | 52 |
| Gl. 1 | 13 | 27 | 7 | 1 | 48 |
| PB. 25 | 3 | 19 | 10 | 3 | 35 |
| MK. 3/2 | 13 | 12 | 3 | 2 | 30 |
| PIL. B. 84 | 8 | 10 | 3 | — | 21 |
| PBIG. seedlings | 2 | 5 | 6 | 1 | 14 |
| HC. 28 | 5 | 3 | 2 | 2 | 12 |
| WG. 6278 | 2 | 6 | — | — | 8 |
| PR. 107 | — | 5 | 1 | — | 6 |
| HC. 55 | 6 | — | — | — | 6 |
| AV. 49 | — | 3 | 2 | — | 5 |
| LCB. 1320 | 2 | — | — | 1 | 3 |
| CHM. 3 | 1 | — | — | 2 | 3 |
| AV. 352 | — | 2 | — | — | 2 |
| M. 11 | 1 | — | 1 | — | 2 |
| AV. 50 | — | — | 1 | 1 | 2 |
| W. 259 | — | — | 1 | — | 1 |
| PB. 183 | — | — | 1 | — | 1 |
| AV. 255 | — | 1 | — | — | 1 |
| | 123 | 260 | 112 | 72 | 567 |
| | (21.7%) | (45.8%) | (19.8%) | (12.7%) | (100%) |

Of many clones not enough assessments are available to allow a more general conclusion and only of Tj. 1, B.D. 5, Tj. 16, old seedling rubber, PBIG. seedlings, PB. 86, Gl. 1 and a few others sufficient assessments are available to allow making a frequency distribution as a tentative estimate of the sensitivity displayed last season. Of some interesting clones, like HC. 28 and PR. 107 there are not enough data available to give us more than a first indication.

Figure 2 shows the frequency distributions for incidence of Oidium on various types of planting material.

FIG. 2


13
43
22
22
Tj
52
10
21
17
Tj 16
19
38.5
17.5
25
BD 5
27
56
15
2
GL 1
8
38.5
38.5
15
Old seedl.
38
47.5
14.5
Pil B 84
14
36
43
7
PBIGS
43
40
10
7
MK 3/2
9
54
29
8
PB 25
40.5
55.5
4
PB 86
None
Light
Medium
Heavy
None
Light
Medium
Heavy

If we again assume that a light Oidium attack does not do appreciable harm to a field, we can draw a vertical line right through all the frequency distributions. The fields on the left hand side of the line did not suffer, those on the right hand side did. Hence I shall refer to the fields on the left hand side as those on the "right" side and the ones on the right hand side as those on the "wrong" side.

For clone Tj. 1 we see that 56% of the fields were on the "right" and 44% of the fields on the "wrong" side.

The fact that about half of the Tj. 1 clearings suffered damage from Oidium, even while disease control was carried out and notwithstanding the fact that 1953 was a light Oidium year, indicates that either this clone is very sensitive or that the method of disease control is not good enough or both.

Clone BD. 5, old seedling rubber and PBIG. seedlings give about the same 50/50 distribution and for these the same conclusion must be drawn. For Tj. 16 and PB. 25 the position is slightly better whereas Gl. 1, MK. 3/2, PIL.B. 84 and PB. 86 show respectively 17, 17, 14.5 and 4% of the fields on the "wrong" side. For these clones we may conclude that in a light Oidium year most fields will escape damage if sulphur dusting is carried out. What the position will be in years with severe Oidium remains to be seen.

From this year's data we may however conclude that the difference in susceptibility of planting material is considerable and estates will be well advised to give due consideration to this point when choosing their planting material. As I already said, there are a few promising clones about which not enough assessments were received to justify a conclusion. I refer particularly to HC. 28 and PR. 107: these should be given a trial, as there are indications that they have a reasonable degree of resistance. The two reports for heavy incidence of mildew given for HC. 28 in Table I, were given by the same estate for two separate clearings.

I have to draw attention to the high incidence of Oidium in the clonal seedlings.

This is not surprising; resistance is the exception and susceptbility the rule (otherwise the disease would not be a serious one) hence we must expect that seedling material not especially selected for Oidium resistance will show the normal general condition of susceptibility. Those who contemplate replanting with clonal seedlings I would advise to watch developments in the next two years and to prepare for crown budding with the resistant clone LCB. 870, if necessary.

### 1.2. Incidence of Oidium with relation to elevation.

From the data furnished by the questionnaire referred to above, it was also possible to obtain an idea about the relationship between elevation above sea level and incidence of Oidium. Since we saw that clones show so much variation in susceptibility the problem of influence of height on intensity of Oidium attack will be studied within a clone and Tj. 1 was chosen for the purpose.

FIG. 3.

*Incidence of Oidium in sulphur dusted fields of Tj.* 1 1952/53.

| Elevation in feet | None | Light | Medium | Heavy |
|---|---|---|---|---|
| 1500 | | | | |
| 1400 | | | | X |
| 1300 | | X | | XX |
| 1200 | | | | X |
| 1100 | | | | |
| 1000 | | XX | X | X |
| 900 | XXXX | XX | XX | XXX |
| 800 | | XXXXXXX | XX | |
| 700 | | X | XXX | X |
| 600 | XX | XX | X | XX |
| 500 | X | XXXXXX | XX | XXX |
| 400 | XX | XXXXX | XX | XX |
| 300 | X | XXXXX | XXX | XX |
| 200 | XXX | XXXXXXXXXXX | XX | XXXX |
| 100 | XX | XXXXXXX | XXXXXX | XXXX |
| 0 | XXX | XXXXXX | XXXX | XX |
| | None | Light | Medium | Heavy |
| | 18 | 56 | 29 | 28 |

Fig. 3 represents again a graph with on the horizontal axis the four gradations in intensity used earlier. On the vertical axis the elevation in feet above sea level is marked off. Each X represents one assessment. We see at a glance that at least below 1000 ft. there was in 1953, in the dusted fields little or no correlation between height and intensity of attack. If any correlation were present such would have been manifest by a concentration of the marks along either of the diagonals. Above 1000 ft. the situation is slightly different, the emptiness in the upper left hand corner indicates that at the higher elevations there were no cases of only light Oidium on Tj. 1. The number of assessments for areas above 1000 ft. are however so small, that this section would be better disregarded altogether.

The result of this analysis is rather surprising as it is the generally accepted opinion that Oidium gets much more severe with increasing elevation. We shall therefore be well advised not to draw any general conclusion and restrict ourselves to the statement that in the light Oidium year of 1953, there was, in the sulphur dusted fields of Tj. 1, no correlation between elevation and incidence of disease. There is one point of practical importance which should be noted, i.e. severe Oidium can occur in Tj. 1 even at sea level, hence planters should not choose Tj. 1 for a clearing at low elevation on the assumption that low elevation is in itself a safeguard against Oidium.

### 1.3. Crown Budding.

Above, when dealing with the susceptibility of clonal seedlings I mentioned crown budding with LCB. 870.

LCB 870 is a familiar name in Ceylon now and everybody knows that this clone is notably more resistant to Oidium leaf-disease than any other clone we know of. The procedure of crownbudding high yielding clones with crowns which are resistant to leaf diseases which are petrimental to the high yielding clones, is already practised on a large scale in Latin America. Still we do not know exactly to what extent the yield of the panel clone is affected by the yielding capacity of the crown clone.

In the proceedings of the Rubber Conference held in Indonesia in July, 1952, we find conflicting statements on the subject, (2).

At our experimental estate, Hedigalla, we have a number of pairs of twinned seedlings; one tree of each pair is crownbudded with LCB 870 whereas the other individual of each pair is crownbudded with Tj. 1. These trees are not yet big enough for regular tapping, but a Morris-Mann test tapping was carried out, which gave the following result.

One hundred and sixty five trees crownbudded with Tj. 1, gave 3587 grams of dry rubber, whereas their twins, crownbudded with LCB 870 yielded 3607 grams. This difference of 20 grams on 165 pairs is negligible. This indicates that at this stage no depressing effect of LCB 870 can be demonstrated. This should however not be taken as proof that depression by a lower yielding crown on a higher yielding panel does not occur; the only permissible conclusion is, that the present experiment at this stage did not give an indication to that effect. In this connection I want to show a photograph of a PB 86 tree crownbudded with LCB 870. This tree was pricked just above and just below the union. Note that above the union the latex ran only for about half an inch, whereas below it ran for quite a distance.

Crownbudding, being a drastic operation, causes a setback to the individual tree and it is well worth knowing how much this setback exactly is. Fortunately we possess a good source for obtaining this information, namely three crown budded areas at Kepitigalla Estate.

Three 1946 clearings of Tj. 1, PB 86 and clonal seedlings situated at different locations of Kepitigalla Estate were partly crownbudded with LCB 870 at four years of age. The crownbudded trees form a solid block in each clearing. In July 1953 the girth was measured in the crownbudded area, and also were measurements taken in a block of 200 trees in each clearing adjacent to the crownbudded part of the field.

The result was as follows:—

| | Not Crown-budded* | Crown-budded* | Diff. |
|---|---|---|---|
| Clone TJ. 1 | 14.9" | 12.8" | 2.1 |
| Clone PB 86 | 15.7 | 14.4 | 1.3 |
| Clonal Seedlings | 16.4 | 13.7 | 2.7 |

*The figures given are the means of 200 measurements. Clonal seedlings were measured at 3 ft. above ground level. Budded plants were measured at 4 ft. above highest point of the union.

If we assume that in the Kepitigalla area the average growth of untapped young rubber trees is between 2.5 to 3 inches per year, we see that the set-back in girth amounted to one year's growth only, even in this case where the

crown budding was done at 4 years. This means, that crownbudded fields if budded at the right time will come into tapping less than a year later than they would if they had not been crown budded.

In case the area to be replanted is considered sufficiently liable to mildew attack to justify crownbudding, I submit the following procedure for your consideration.

(1) The field is planted at an initial density of 400 seedlings to the acre. These 400 plants may be planted in a more or less square system or in a hedge system.

(2) When the field is 1½ to 2 years old, about 250 trees, more or less evenly spaced over the area, are selected for crownbudding.

In selecting these trees, the main criterion must be growth, but it will be wise to submit all the selected trees to a pricking test as well and to inspect the latex flow. If the latex flow is poor the tree should not be used.

(3) When the wood at 8 ft. high is old enough to be budded, crown-budding must be done as soon as the season is suitable.

If on the trees to be crown budded any side branches occur below 8 ft these branches need not be removed; only if there is whorl of four or five branches the number should be reduced to two.

It has been found that one or two side branches below the bud-patch do not influence the sprouting of the bud and do not retard the growth of the scion during the first four months, whereas such branches give considerable protection against wind damage.

The presence of the unbudded trees in the field and the low branches on the trees, together with the flexibility of the young stems will reduce wind damage to a lesser level than usually experienced.

If a budding success of 70% is obtained, there will be about 175 crown budded clonal seedlings per acre, which is quite enough as an initial stand. It will be realised that budding, inspection and aftercare of the budded plants will be cheaper if the hedge planting system is followed. The matter of hedge planting will be more fully considered later in this paper.

### 1.4. Use of LCB 870 as a clone.

The use of LCB 870 as a normal "budded stump" is of course a simple manner to reduce incidence of Oidium to a negligible level under average conditions. In this connection we must however remember, that in its country of origin, this clone was never used on estate scale because its yielding capacity compared unfavourably with the yielding capacity of the clones in general use.

Planting of clone LCB 870 as a budded stump therefore means accepting a lower yield per acre than is obtainable with modern planting material. As a compensation one obtains freedom from Oidium damage without fungicide application. In order to be able to decide when this "bargain" should be made, one should know.

(1) what will be the difference in yield between LCB 870 and the alternative type of planting material under the environmental conditions concerned, if effective disease control on the latter is achieved.

(2) what will be the cost of effective disease control under the given circumstances.

If the answers to these questions are known it is a matter of simple arithmetic (and some speculation as to the price of rubber) to decide what is the most economical course, either: to accept the lower yield of LCB 870 and to be able to do without disease control or: to aim at the highest possible yield per acre and to rely on efficient disease control.

It will be a matter of at least a few more years before the necessary answers will be known.

Oidium control by means of fungicides has not yet proved itself successful under *adverse* conditions and hence costs cannot even be estimated. Neither is the yield of the better clones and of clonal seedlings at high elevations known, whereas the yield of LCB 870 is also a point on which some more information is wanted.

## 2. WHAT CAN BE DONE AT THE STAGE OF REPLANTING TO REDUCE COSTS OF FUNGICIDE APPLICATION?

Every measure which will facilitate transportation of machinery through the area will help to reduce the costs of fungicide application. Hence it is advisable to plant along the contour and to plot a large number of level paths before lining and holing is undertaken.

It is at this stage impossible to foretell how disease control will be carried out at the time when the 1954 clearings will be in tapping. It is possible that, as we learn more about dusting, this method will prove even more useful than it appears to be at present. It is also possible that improvement in machinery will cause spraying to become more popular and finally it may be that the aerial spraying contracts to be carried out next year will prove to be so successful that spraying from aircraft will become general practice.

### 2.i. Requirements for dusting.

Let us first consider the requirements of dusting.

Since at last small dusting machines of sufficient power have appeared on the market, the requirements for dusting are easy to meet. All that is required is a system of footpaths, preferably not more than 100 ft., apart. For efficient dusting of rubber the distance between the tracks covered by the duster should not exceed 200 ft. and it appears safer to rely on 100 ft. "depth of treatment" only. I shall try to explain why. It is quite true, that the cloud of sulphur appears to travel many hundreds of yards under favourable circumstances, but we have no guarantee that the fine particles capable of travelling great distances also possess the physical properties necessary to *settle* on the leaves to be protected. It is obvious, that the lesser the tendency of a particle to settle, the better it travels and vice versa. Experiments with spores of plants of different sizes have shown, that the tendency of an airborne body to settle on an exposed surface decreases with its size (1). On the other hand the capacity of adhering to the leaves after settling improves with decreasing size. We may say, that larger particles settle well but do not stick, while small particles stick well but

settle badly. Hence we must find the golden mean, the size range in which the particles travel a sufficient distance, settle well and adhere well. The Institute hopes to carry out dusting experiments with sulphur powders of different size ranges; for this purpose we have on order quantities of sulphur with particles ranging from 3 to 5 microns, with particles from 10 to 15 microns and with particles from 20 to 25 microns. It is hoped that these tests will supply some information as to the most desirable size range for dusting sulphurs. Once this range is known, manufacturers can be asked to produce dusts of a specific size range instead of specifying fineness according to 'mesh'.

In this connection I may mention that the most effective sulphur ever experimented with at the R.R.I., proved to have a size range, between 20 and 40 microns The above explanation shows why one should not rely on a great depth of treatment, even if the dust appears to "travel for miles".

### 2.2. Requirements for spraying.

When we speak about spraying we must specify whether we mean "high volume" spraying or "low volume" spraying.

High volume spraying is the method whereby the tree is sprayed till the spray drips from the leaves. When applying this method the quantity of liquid used is at least 100 gallons per acre and often more.

When "low volume" spraying is done the quantity of liquid used may be as low as a few gallons per acre and is rarely more than ten gallons/acre.

A high volume sprayer consists of a pump and a hose with a lance. The pump creates a high pressure in the lance, up to 800 lbs. per square inch. Under the influence of such pressure the liquid is forced out of the nozzle and is broken up in the process.

It is obvious that the machinery necessary to deliver a hundred gallons of liquid per acre at a pressure of 800 p.s.i. will be heavy and expensive. Besides, all information available on the subject, indicates that even with the best available machinery a height of 70 ft. is unattainable without a tremendous waste of liquid. For these reasons I do not think that high volume spraying is a practical proposition for Ceylon rubber.

A low volume sprayer consists of a fan which forces a large quantity of air at great speed out of a wide nozzle. In this nozzle the liquid is atomized under low pressure. The droplets are broken up further by the air stream and are carried off in the same way as dust particles in the air steam of a duster. The construction of a low volume sprayer is therefore not principally different from the construction of a dusting machine and should not be much heavier or more expensive if it were not for the larger capacity required.

In low volume spraying we must distinguish between 'drift spraying' and 'blast spraying'. Drift spraying is comparable with dusting and may be looked upon as dusting with liquid particles. This form of spraying will be suitable for rubber as long as the leaves are very small. When however the leaves get larger and a certain penetration is required, drift spraying will not work and blast spraying is necessary. Hence the larger capacity required for the sprayer as compared to the duster.

For ordinary square planted rubber a sprayer with a range of at least 100 feet appears to be necessary for effective spraying while covering sufficiently

large areas in the time available, for low volume-spraying should, like dusting, be strictly limited to the windless hours of the day.

I have not yet had the opportunity to test any machinery of such capacity and from the information available such machines appear to weigh about a ton each. However, I do not think that building roads capable of carrying a one ton machine at hundred feet intervals, would be an economical proposition under Ceylon conditions.

Low volume machines powered with relatively small engines, say about 5 h.p. might be used for spraying of rubber and have a fair capacity if the trees were planted according to the hedge planting system.

If we assume a planting distance of 5 × 50 ft. a small mistblower like for instance the "Micron Sprayer" could, when travelling at 2 m.p.h. do 2000 trees per hour of actual spraying, which corresponds to approximately 10 acres per hour.

Very little hedgeplanting has been done in Ceylon up to the present time but it is my opinion that this method has several advantages especially under Ceylon conditions. Experiments in hedgeplanting have been done in Indonesia and the results revealed no undesirable effects on the growth of the trees, while the yields were on the same level as usually obtained from the same kind of planting material under square planting conditions.

Hedge planting will not cause an increase in production but it may certainly reduce cost of production. In this connection I may mention

a. cheaper tapping,
b. cheaper inspection and treatment of tapping panels,
c. cheaper weeding,
d. cheaper disease control (also of Fomes)
e. the system opens the possibility of replanting and bringing into tapping of the new stand, while still deriving some crop from the old stand. This would encourage replanting with new planting material as soon as it becomes available.

**Literature:**


1. Gregory P. H. Deposition of air borne particles on trap surfaces. Nature, London, 166 (4220): 487 1950.

2. Lasschuit J. A. and J. S. Vollema, The Mildew resistant clone LCB 870. Archief voor de Rubbercultuur—Conference Number May 1953.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## QUESTIONS & ANSWERS

**Mr. L. C. de Mel:**—Please tell us what you consider has been the drop in Yield per acre on budgrafts and clonal seedlings, due to Oidium in 1951 and 1952.

**Ir. J. H. van Emden:**—The loss of crop suffered in budded rubber ranges from insignificant to nearly complete.

Insignificant losses occur in young fields planted with the less susceptible clones in the low country.

The nearly complete loss of crop occurs in older fields planted with susceptible clones at higher elevations. In such fields secondary Diplodia die-back following Oidium attacks is of course partly responsible.

For clonal seedlings I cannot give as accurate an answer since we do not have sufficient fields of clonal seedlings and I do not have yields of fields which have been in tapping more than 7 years. I expect the influence of Oidium to be the same on clonal seedlings (unless especially selected for Oidium resistance) as Tj. 1.

I base this conclusion on the figures published in the Combined Quarterly Circulars for 1951 in C.A. de Silva's article "Yields of budded rubber and clonal seedlings in commercial tapping" in Table V. If I add up the yields published for clonal seedlings in each year of tapping and express the yields of each year as a percentage of the first year's yield and if I do then the same for the Tj.1 fields listed in the same table I find the following:

| | Clonal seedling | Tj. 1. |
|---|---|---|
| 1st Year ... | 100% | 100% |
| 2nd Year ... | 132 | 134 |
| 3rd Year ... | 153 | 167 |
| 4th Year ... | 197 | 198 |
| 5th Year ... | 225 | 203 |
| 6th Year ... | 209 | 203 |
| 7th Year ... | 240 | 236 |

If one wishes to estimate loss of crop suffered in any particular field I suggest that the yields obtained from that field be plotted in a graph against the year of tapping and the curve obtained be compared with the curve which represents the normal trend of the yield for rubber which curve can be obtained from for example Djikman's: Hevea, Thirty Years of Research.

**Mr. E. C. K. Minor:**—(1) "Just because trees 'Winter' early does not mean they escape mildew attack".

"The BD. 5 on Govinna Estate 'winter' very early and yet this clone always gets a bad attack."

**Ir. J. H. van Emden:**—Early wintering is certainly no guarantee that a clone will escape mildew attack, but we observe that mildew starts rather mildly and then goes through a peak period and tapers off towards the end of the wintering period.

I think that the explanation for this phenomenon is, that in the beginning of the wintering season there is little inoculum about. As the amount of foliage in the susceptible stage increases more spores are produced and chances of infection become greater. The decrease towards the end of the epidemic is probably due to the fact that the number of susceptible leaves becomes smaller and also to the action of parasites of Oidium.

**Mr. E. C. K. Minor:**—(2) Why are only seedlings and not budgrafts also recommended in the suggested procedure for crownbudding.

**Ir. J. H. van Emden:**—The procedure referred to is my suggestion for planting 400 seedlings per acre, selecting 250 good growers and budgrafting those at 8 ft. after checking that there are no obviously poor yielders amongst them by some sort of pricking test. The same procedure could also be followed with budgrafts but if a good type of seedling has been used for stocks and if the stocks have already been selected for growth in the beds before budding, there is with budgrafts no point in starting with an initial stand of 400 plants per acre. If one wishes to crown bud clonal plants I advise to begin with an initial stand of say 200 this will allow for a number of failures and for some selective thinning.

**Mr. A. G. Huntley:**—"Given favourable weather always and that the period from dawn to 9 a.m. is the most practical during which to dust, if it were possible to utilise the hours of darkness, would dust carry and adhere to leaves better than in the early morning and if so, which are the best night hours".

**Ir. J. H. van Emden:**—The question as to what is the best time for dusting has caused quite some confusion and I shall try to make my viewpoint clear.

In the literature on this subject the recommendation is to be found, that dusting should be done at such times when there is little or no wind; also the statement is made, that if the leaves are wet from dew the dust will adhere better than when the leaf surfaces are dry.

It is a well known fact that the wind is generally at its minimum strength at about sunrise, at which time the leaves are also wet. Hence I recommended dusting as early as possible.

Since from several sides the objection was made that the dust would not rise until after 0900 a series of experiments was started and it was found, that the dust could be blown up to the required height at all hours of the night and early morning provided there was no wind. In accordance with the above I made the statement that there were no objections to start at daybreak and if the area to be treated could not be covered during the time from 6 a.m. to 9 a.m., it was better to start before daylight and to use lights than to do dusting during the heat of the day when conditions are decidedly unfavourable. To this I added that in European orchards, where low-volume spraying is done, such often takes place during the night when conditions are more favourable for mist spraying than during daytime.

For sulphur dusting in Ceylon I advise to try to finish the work between daybreak and the time when the leaves are dry and the wind starts blowing. I don't see any objections to dusting during the night (if good paths and proper lighting are available). I must however add, that at night also there can be too much wind. If one wishes to do night dusting the best thing to do is to study local conditions in each field and to adapt the programme to the observations made on the spot.

I have no reason to assume that the dust would either carry further or adhere to the leaves better during the night than during early morning hours.

**Mr. Alban E. Wijesekera** wants our opinion on the idea of planting LCB 870 at a higher initial stand about 300 trees per acre—, in order to make up for the lower yielding capacity of this clone.

**Ir. J. H. van Emden:**—In my opinion it is not possible to eliminate a difference in yielding capacity between two clones by planting them at a higher stand.

I expect that there is an optimum density for rubber which is determined mostly by growing conditions and to a lesser extent by clonal characteristics such as the shape and size of the crown, the properties of the root system and the capacity for bark renewal but to the best of my knowledge there is no relationship between the yielding capacity of a clone and its optimum density.

For this reason the difference in yielding capacity between LCB 870 and any given clone will always be noticeable, provided they are compared at the same stand per acre. If the prevailing growth conditions permit an initial stand of 300 trees of LCB 870 per acre the chances are, that they will also permit the same number of trees of a different clone per acre and the difference in yield will still be there.

# THE WORK OF THE SMALLHOLDINGS DEPARTMENT WITH SPECIAL REFERENCE TO THE RUBBER REHABILITATION SCHEME

BY

**W. I. Pieris, Smallholdings Propaganda Officer**

**Introduction.**

I consider it a privilege to have this opportunity of saying a few words about the work of the Smallholdings Department of the Rubber Research Institute to an audience so representative of the Rubber planting interests of Ceylon. Many of you, concerned as you are with your own problems on your much larger plantations, are often apt to forget that out of a total of 655,501 acres of Rubber in Ceylon, 171,542 acres consist of smallholdings of under 10 acres and another 140,715 acres of small estates of 10-100 acres, aggregating between them as much as 48% of the Island's total Rubber acreage. The Rubber industry is the second largest industry in Ceylon and nearly half a million people depend on it for their living. I venture to hope, therefore, that a few remarks regarding the services made available by my Department to the Rubber smallholders and small estate owners of Ceylon, who constitute such an appreciable portion of the Rubber industry, may not be entirely without interest to some of you. Approximately 51,000 acres out of the total 655,500 acres of Rubber in Ceylon consist of new-planted budded rubber, the bulk of which, namely about 39,000 acres, are peasant and middle-class areas planted under the New Rubber Planting Scheme.

**Origin and Development.**

The want of an advisory service to cater for the needs of the Rubber small owner in Ceylon was realised by the Board of Management of the then Rubber Research Scheme and I was sent on a two months' visit to Malaya in September 1935 to study the Smallholders' Advisory Service of the Rubber Research Institute of Malaya. On my return, a start was made with the appointment in November 1936 of two Rubber Instructors at Matugama and Horana to advise and assist the smallholders of the Kalutara district and of a Clerk-Translator to attend to clerical work and translation of advisory leaflets. On the results of the useful work done by these officers, four additional Instructors for Galle, Kelani Valley, Kandy and Ratnapura were appointed in 1938 and four more for Kegalla, Gampaha, Akuressa and Elpitiya between 1941-1946. In October 1948, with the taking over from Government of the administration of the New Rubber Planting Scheme, which in itself involved the advisory work connected with some 40,000 acres of new land planted with improved Rubber, the staff was further increased to a total of 3 Assistant Propaganda Officers, 4 District Field Officers, 31 Rubber Instructors, 4 Clerks and 2 Peons, at which strength more or less it functions at present. All officers are given a special course of training before they are sent to their ranges. During the course of the present year we have, in addition, been requested to undertake the work of advising smallholders who will be "replanting" under the Rubber Rehabilitation Subsidy Scheme. This work is already under way and is likely to increase considerably in magnitude during the next few years.

**Functions and Scope.**

The principal function of the Department is to render free advice and assistance to Rubber smallholders in all matters connected with the planting, maintenance, manufacture and marketing of rubber. These services are normally available to all those whose total Rubber acreage does not exceed 30, but with the taking over of the New Rubber Planting Scheme and now the advisory work of the Rehabilitation Scheme smallholdings, this definition has had to be modified to suit various contingencies.

**Services Rendered.**

Services rendered are many and varied. No small owner need have a rubber problem today concerning which he cannot obtain free advice from the Smallholdings Department or from one of its trained Rubber Instructors, 31 of whom are stationed in the main Rubber districts of the Island. Many practical benefits such as high-yielding planting material, free lining for holes and drains with the road-tracer, grants for soil conservation, mesh for strainers, unadulterated acid for coagulation etc. are supplied. Systematic visits are paid to holdings by Instructors and demonstrations given in sheet-making, tapping, budding, disease-treatment, compost-making etc. Over 300 demonstration and 600 private smokehouses of standard type, specially designed for economy of cost and efficiency in smoking, have been constructed for smallholders under Instructors' supervision. The formation of Sheet Co-operative Societies, where a number of smallholders bring their latex to a central factory and it is weighed, coagulated and smoked into grade 1 sheet by a trained rubber-maker, is encouraged. Societies have been formed and are functioning satisfactorily at Hataraliadde, Dapiligoda, Kahagalla, Aruppola etc. where the quality of sheet made is never below grade 2. More societies can be formed but for the difficulty that has been encountered in obtaining from the Co-operative Department the initial loan of Rs. 2000/- to Rs. 3000/- required by a Society for buying rollers and building a smokehouse. Ten Latex Centres have been organised at Kalutara for supplying smallholders' latex to the Dunlop Latex Corporation at Katukurunda, with considerable profit to the smallholders concerned. The Corporation, after fetching the latex by their own van, used to pay 2 cents below the top market price of sheet for every pound of dry rubber supplied as latex, which was considerably more advantageous to smallholders than making sheet. Unfortunately, owing to losses sustained by the Corporation after the China Agreement, the price paid has now been reduced to 10 cents below the market price and there is some uncertainty about the continuance of the scheme. Soil conservation grants are paid to peasant-class New Rubber Planting Scheme permit-holders and a sum of Rs. 11,362 for instance was paid to 233 permit-holders in 1952. Work done is measured by a Rubber Instructor and checked and certified by a higher officer before payment is made. The suitability of all lands for middle or peasant-class new-planting permits is reported on by Rubber Instructors to the Rubber Controller before permits are issued. 3318 such permits, comprising 5332 acres, were issued in 1952. Simple Rubber literature on subjects which are of interest to smallholders is printed and issued both in English and Sinhalese. Smallbolders' Leaflets are available on Budding, Replanting, Sheet-making and Smoking, Tapping of Young Budded Rubber and Rubber Production on Smallholdings.

**Rehabilitation Scheme.**

The need for some kind of financial assistance from Government to enable small owners to replant their uneconomic Rubber plantations has been repeatedly stressed in my reports and the launching of the Rehabilitation Subsidy

Scheme this year has supplied a long-felt want. Large numbers of smallholders (under 10 acres) and small estate owners (10-100 acres) have already applied to the Rubber Controller for permits and it is to be expected that their numbers will increase. The large sums of money to be spent on the scheme and its vast economic importance make it essential that a 'good job' is done and the best material planted, not only on the larger well-managed estates but also on the numerous smaller units scattered in many districts.

Arrangements have been made for the field staff of my Department to pay special attention to this work. The Rubber Controller furnishes me with particulars of all permits issued to smallholders, which are promptly forwarded to the Rubber Instructor of the area concerned. He visits each holding within 2 weeks or as soon thereafter as possible, gives necessary advice for the commencement of work and "opens" a special printed form for each holding, which will serve as a record of its progress from time to time. At each subsequent visit he will record on the same form the progress made and new instructions given. Frequency of visits will, to some extent, depend on Instructors' other work, but priority will be given to this work as far as possible and additional staff appointed if and when it should be needed. Instructions given will be based on the recommendations of this Department's Leaflet on Replanting (No. S.H. 1) which has been recently revised by me to conform to the requirements of the Rehabilitation Scheme and is available both in English and Sinhalese. To avoid confusion it is necessary that Visiting Agents and Superintendents who will inspect holdings for approving grants, should study the official instructions recommended for smallholders by the Rubber Research Institute and advice them on identical lines.

Field operations connected with replanting are familiar to most planters and only a general outline as applicable to smallholders need be mentioned. Instructors take the precaution of verifying that a permit has actually been issued before advising on the commencement of work. Felling, burning and clearing are best done before holing, as this will pevent damage to holes from falling trees and allow for unhampered lining and holing. Moreover on these small poor-yielding plantations, holing is not a lengthy operation and slaughter-tapping is not so important. The most suitable method of felling is to dig round the 'bole', cut the main lateral roots and have the trees pushed over by an elephant. Poisoning with Sodium Arsenite has certain disadvantages and is not recommended under the Rehabilitation Scheme.

For budded stumps, TJ. 1 selfed clonal seedlings and P.B.I.G. seedlings a minimum stand of 180 points per acre is necessary. This is obtained by holing at 30′ × 8′ (avenue system) or at 20′ × 12′. For mixed clonal seedlings a minimum of 250 plants per acre (for subsequent thinning) is required, whose spacing would be 35′ × 5′ (avenue) or 20′ × 8½′. The avenue system of wider rows has certain advantages. Plant rows on sloping land should always be on the contour and free lining will be done by Rubber Instructors. Holes should be 2′ × 2′ with a depth of 2′ in the centre. Existing drains can be utilised or new contour drains cut between every two plant rows. Drains should be 1½ ft. deep by 2 ft. wide with uncut earth blocks of 2 ft. left at intervals of 15ft. Earth from drains is heaped in a continuous ridge along lower side. Where stones are plentiful, stone terraces may replace drains.

The proper filling of holes is important and should be done with top soil, with ½ a basket of wood-ash, 6-8 ozs. of Saphos phosphate and one basket of decomposed cattle or compost manure mixed in the upper half.

Only the best approved planting material will be allowed and large Government nurseries for providing both clonal seedlings and budded stumps for most if not all smallholders have already been established at Egaloya by the Rubber Research Institute and at Walpita, Horana etc. by the Department of Agriculture. All smallholders, therefore, should first make an application for their plant requirements to the Rubber Controller before making other arrangements. Applications should be made as soon as requirements are known and well in time. Clonal seedlings from Government nurseries will be available for issue from May/June 1954 onwards but budded stumps are not likely to be ready till early 1955. The costs of plants supplied from Government nurseries will be deducted from the subsidy at fixed rates. Those who fail to obtain their requirements of plants from Government nurseries, should book them from other "approved" sources, a list of which can be obtained from the Rubber Instructor, or establish their own nurseries with the advice of the nearest Rubber Instructor. Planting material from Government nurseries will not be available to owners of estates of over 100 acres in extent, who are expected to provide their own material. Smallholders planting mixed clonal seed at 250 points per acre must clearly understand that they are required to thin out, in stages, to a final stand of 150 per acre. If not disposed to do so, they are advised to plant budded stumps or TJ. 1 selfed seed @ 180 per acre.

Planting ordinary seed at stake and budding in the field later is not permitted to Rehabilitation Scheme smallholders.

It would be essential for all replanted smallholdings to be manured. The recommended mixture is R465 and the dose 1 lb. per tree in 1st year, 2 lbs in 2-4th years, 3 lbs in 5-7th years and 4 lbs. thereafter. It is preferable to give this in 3 or 4 small doses during the year rather than in a single large dose.

On the generally denuded and infertile soils on smallholdings every effort should be made to establish a good mixed ground cover which would be of great value in replenishing fertility by adding to its humus and also help to prevent erosion.

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## QUESTIONS & ANSWERS

**Mr. E. C. K. Minor.**—Do I understand that seed from existing P.B.I.G. seedling areas in Ceylon is recommended for use? I have not noticed that any such areas are given in the Rubber Controller's List of Approved Areas for Clonal Seed. One can hardly expect Smallholders to cope with the known difficulties attached to the importation of the seed and its immediate germination. Does the Rehabilitation Board propose to attend to this early work if requests for such seed are made by the Smallholders?

**Mr. W. I. Pieris:**—No. It is correct that such areas do not appear in the Rubber Controller's List of Approved Areas for Clonal Seed, because seed from *Ceylon* P.B.I.G. seedling areas is considered as "second generation" seed and such seed is not recognised as approved material. Actually replanting smallhodlers have no need to bother about planting material at all as large supplies of approved clonal seedlings as well as budded stumps are being provided for them by Government. However there is nothing to prevent any individual smallholder who wishes to plant P.B.I.G. seedlings from doing so by importing the seed through the local agents, just like anyone else. Once the

seed is procured, Rubber Instructors will assist smallholders in germinating and planting it out correctly.

**Mr. Alban E. Wijesekera:**—(1) It has been my long decided opinion that most of the Smallholders, particularly of the Peasant-Class will not successfully bring up and maintain Budded-Rubber. Because, most of them simply cannot and will not give the necessary doctoring and nursing demanded by budded rubber for success, nor the more careful attention needed in upkeep (inclusive control of Oidium) and tapping.

(2) The time for our smallholder to go in for budded rubber is yet to come. Until such time, it is best he sticks to Seedling Rubber. With good clonal-seedling rubber; well selected, cultivated, maintained and tapped, he can be sure of 500 lbs. per acre, on the low side; produced at more economical cost than from budded rubber.

(3) I think the Department would do well to encourage and advice Smallholders to concentrate on clonal-seedling rubber in preference to budded rubber.

**Mr. W. I. Pieris:**—There are two schools of thought: (a) those who like Mr. Wijesekera are convinced that smallholders should only plant clonal seed and (b) those who are of opinion that, in any large scale replanting or new planting scheme, where a considerable proportion of the planters are small and middle class owners, it is to the general benefit to plant the best available material and not the second best and that advisory assistance should be provided by the state to plant and maintain it properly.

The policy of the Rubber Research Institute etc. has, therefore, been not to be dictatorial in the matter and compel smallholders to plant clonal seed alone but to explain the pros and cons of both and let each individual owner decide, according to his circumstances, what he should plant.

It is also not every small and middle-class owner who neglects his new-plantation. Our experience in the New Rubber Planting Scheme shows that approximately 21.5% of holdings are well-tapped. There is also the fact that although it may be argued that budded rubber suffers more from bad-tapping etc., clonal seedlings are not immune to such damage. In fact, in regard to oidium control, to which Mr. Wijesekera has referred, budded rubber has an advantage over clonal seedlings in that there are oidium-resisting clones like LCB. 870 whereas there are no clonal seedlings which are immune from oidium so far. Even in Malaya, I understand from Dr. Newsam who is here today, that smallholders are not restricted to clonal seed alone. Taking all the circumstances, I feel that the present policy is the best.

# PLANTING MATERIAL

BY

**C. A. de Silva, Botanist**

## Introduction.

When we deal with a perennial crop such as Rubber, no apology is necessary for the hiatus between issues of recommendations on planting material for use on a large scale in any particular country. The rubber growers in Ceylon have over twenty years experience in replanting work, and it must be obvious to them by now that both budgrafts and clonal seedlings call for periods from 15 to 20 years of testing before any particular material can be planted extensively on a large scale in the various planting districts of Ceylon. In fact the testing is not really complete until yields are tested on renewed bark. This further testing is necessary to ensure that economic returns are obtained throughout the life of the rubber tree.

## Early work of the Rubber Research Institute.

Together with the co-operation of the Department of Agriculture at Peradeniya, the success of the budgrafting procedure established in Indonesia through the efforts of Dr.'s Cramer and Maas was confirmed in this country about 1920. Almost every estate was visited for selection of the highest yielding trees in the old seedling rubber with good secondary characters. After the preliminary test-tapping of selected trees, about 150 clones were established and planted out in 1926, 1927, 1928 and 1935 at our sub-station at Nivitigalakele.

From this collection of clones only three clones MK3/2, WG. 6278 and Hillcroft 28 emerged as high yielders of an order worth further trials on a larger scale. These three clones still remain with us as our better yielding types of planting material as budgrafts. The clones also represented the maximum developments possible by selection amongst the old mixed unselected seedling rubber on Ceylon estates, and no further selection was possible until the advent of clonal seedlings. From our experience with the establishment of clones by budgrafting from high yielding seedlings, it was apparent that there were limiting factors which restricted the transmitting of the desirable characters, like yield and growth, to the vegetative progeny by budgrafting from a selected high yielding seedling. One of the most serious drawbacks was the fact that high yields of the old seedling rubber on estates were recognised about the 20th year of growth, and the established clones invariably produced their high yielding characteristics too late in their tapping history to be of any economic value. We are now at a stage when we can make selections from clonal seedlings, which are capable of giving high yields in their 3rd year of tapping.

As early as 1930 we imported seed from the Prang Besar Isolated Gardens and Tjikadoe seed Gardens for testing at Nivitigalakele station. Three tree clones were established from the best yielders and planted out as "PBS" clones in 1935. Six of these clones have been planted out in large scale trials in 1945 at our Hedigalla station. These clones are now in their first year of tapping.

Attempts were made to obtain hand pollinated seed in 1926 from clone Heneratgoda 2 and local clones. The results were on the whole disappointing, and it was not until 1939 that we were able to undertake a systematic scheme of pollination work under the supervision of Dr. C. E. Ford, Geneticist—from 1939 to 1945.

With the exception of 1942, a programme of hand pollinations was carried out from year to year until 1945. A total of 78,880 pollinations was carried out and approximately 6,000 seeds were harvested. Most of this material was planted out in areas opened out from 1941 to 1947 at Nivitigalakele, and Hedigalla experimental stations. Five tree clones were established from about 80% of the hand pollinated seedlings planted out, by taking the pollarded top half of each seedling as budwood, thereby saving about 8 to 9 years in selection of clones from clonal seedlings.

From 1941 to 1946 the hand pollinated seedlings, and the five tree clones derived from these seedlings, were planted out in adjacent clearings. The Institute now has over 4000 clones on trial from clonal seedlings, which represent crosses from the best of modern high yielding clones both foreign and local.

The post war period saw the departure of most of the overseas Research Staff, who initiated a number of the earlier investigations. Over ¾ of the total acreage of the Institute's experimental stations are now supervised by the Botanical Department with the help of the Estate Department.

Unfortunately some of the earliest clones developed since 1939 have still not been tested sufficiently for inclusion in large scale replanting programmes at the present time. The best of the NAB clones established from high yielding Tjikadoe seedlings, No.'s 12, 15, 17 and 20 are yielding over 15 lbs. of dry rubber per tree per year in the early years of tapping. These have been planted in a final large scale trial at Dartonfield with controls of the best yielding foreign clones. Budwood has been distributed to estates in various districts for small scale trials as soon as the limited quantities of budwood distributed are sufficiently multiplied.

Trials with foreign clones initiated in 1940 confirmed the high yielding qualities of clones RRIM. 501, 513, AV. 255, PR. 107, LUN. N. WAR. 4. This information has been most helpful in our efforts to replant under the Government Rehabilitation Scheme.

We have also over 20 new RLD. clones all giving promising yields of 14 to 15 lbs dry rubber per tree per year about the 4th tapping year. Each of these clones are planted on 5 to 6 acres in areas of 75 to 100 acres opened out in jungle in our Hedigalla station in 1952 and 1953. This has been made possible in recent years owing to an increase in staff and financial resources.

The early results of seedling families from hand pollinated seedlings have shown that our local clones MK 3/2, WG 6278, RLD. 8, HC. 28 are very promising seed parents, and with the knowledge of the good parentage qualities of a number of foreign clones, we will be able to make very reliable selections of planting material as clonal seedlings in the future.

With the limited Research Staff almost since the inception of the Institute, it is inevitable that we have to fall back on the findings of other better equipped Research Institutes farther east. Where hereditary characteristics have been established in other countries with regard to planting material,

the results will apply equally well to this country with a few limitations and I owe no apology for authenticating my statements with information from results obtained out-side this country. Most of the findings have been confirmed by us in trials carried out on a smaller scale especially on problems of budgrafting, clonal seedlings, stock-scion effects, and tapping problems. We have also, for our immediate needs initiated in recent years, large scale experiments on crown-budding in connection with the use of the resistant clone LCB 870 against Oidium infection.

Having given you a short resume of the work done on planting material during the past 12 to 13 years, which goes back to the year of our last Conference in 1940, I now turn to the more immediate practical implications of the results obtained from our experiments.

In dealing with planting material I do not hesitate to start off with planting material in our nurseries. Mistakes and poor standards of agricultural practice here will mar the future of many large acreages of rubber planted as budgrafts or clonal seedlings in this Island.

**Nurseries.**

It is essential that we select healthy vigorous growing seedlings in the nursery for use as stocks and for planting out as clonal seedlings. In experiments carried out here and in outside countries the seeds of clones TJ. 1, AV. 163, BD.10 PR. 107, TJ. 16, WAR. 4 were found to make better stocks than other types of seed. Unfortunately at the present time, the choice of seedlings for stocks is very limited owing to the poor seed-set on desirable clone parents in this country in recent years. Seed-set is restricted by attacks of Oidium heveae and losses of seed pods also occur later in the year from Phytophthora pod-rot. Our recommendations provide for a stand of about 30,000 seedlings per acre. and a choice of seed for nurseries will take the following order :—

1. Seed of clone TJ. 1, which is considered as one of the best types of seed for stocks, can be used for planting out directly as clonal seedlings, especially if the collections, are made centrally from large monoclonal blocks.

2. Mixed clonal seed for use exclusively as stocks, and for small scale trials of clonal seedlings according to seed families. This seed is now recommended for large scale planting under the Government Subsidy Scheme in 1953.

3. Unselected seed from old seedling rubber and clonal seedling areas, sometimes called "second generation" seed.

It is obvious that stands of over 30,000 seed per acre will take longer to develop into buddable girth than with the recommended density. There is a limit to stimulation with artificial fertilisers. Under our climatic and soil conditions the best of the buddable stocks can be utilised from the end of the 12th month up to the end of about 2½ years.

Unselected seed will call for selective thinning to a greater extent than clonal seed. Thinning is best done in 3 stages; the first about three months, when it is possible to eliminate the permanent "yellows"; the second after six months for eliminating the poor growers by observation on height and girth. A final thinning is carried before budgrafting. According to the type of seed,

30,000 seedlings per acre of nursery should be reduced to 25,000 and 20,000 depending on the type of seed. The poorest unselected seed may have to be thinned down to 15,000.

Sufficient evidence is available to prove that there is a strong stock-scion effect. Experiments in outside countries have shown that with certain stocks the yield of clones is about 40% higher than ordinary unselected stocks.

In a high density experiment in the AVROS station nearly 22% of a total stand of 625 trees never reached tappable girth. This was attributed to the use of unselected stocks. In normal plantations poor stocks account for backward growers reaching tappability long after good and average growers. Due to subsequent competition with the better growers, the poor trees remain poor throughout the tapping history of the plantation. It is also known that the formation of latex is closely linked with the growth of the plant and is a part of the physiological processes that contribute to the growth factor.

It is obvious that the rubber grower who plants a clearing with stocks left over after the third year will not have the same high yielding stand of budded rubber as the one who establishes budgrafts of the same clone with the best selected stocks in the first two years of growth in his nurseries.

The same principle must be applied to the method of planting seed-at-stake and budding in the field. It is necessary to plant 2 to 3 seedlings per hole for selective thinning out of the poorest stocks before budgrafting. This method is recommended in districts with low rainfall generally without a reliable wet weather period for transplanting.

For successful budgrafting and establishment of budded stumps in the field, it is necessary to use stocks of one inch diameter and over at ground level, using the budwood of normal thickness. Any departure from these standards to smaller stocks must be done only on a trial scale. Such trials have been carried out in Malaya and Indonesia in recent years. It can find no place at the present time on any large scale replanting programmes. Somewhat smaller size stocks can, however, be used when budding directly in the field, where there is no transport and transplanting.

It is well to remember that the viability of rubber seed is lost quite rapidly and the germination can drop to about 50% in 3 to 4 weeks. Fresh seed can be stored up to about 2 months in moist charcoal or saw-dust or a 50:50 mixture of both. About 15% moisture is satisfactory.

Clonal seedlings and budgrafts in the form of budded stumps are the two forms of planting material used. From my experience of advisory work during the last decade it is clear that most rubber growers do not have a clear conception of the characteristics of the two forms of planting material. Unless one has this knowledge, it is impossible to appreciate the recommendations put out by the Institute with regard to the choice of planting material as budgrafts or clonal seedlings. To make this difference between seedlings and budgrafts clear it is necessary to digress somewhat from the strictly non-technical approach of my subject to an important principle in genetics, which provides for the transmitting of hereditary characters from one generation to another in higher organisms of plant or animal origin.

Although these principles are put out in most elementary manner, it is necessary to realise that in nature the actual procedure is highly complicated.

Nature has provided for the transmitting of hereditary characters from generation to generation by means of certain "hereditary units" or chromosomes located in a specialised section of each plant cell. Each organism has a fixed number. For man it is 48 and for Hevea Brasiliensis it has been confirmed at 36. It will be beyond the scope of this paper to go further into the composition of these units, but it is sufficient to state that all the characteristics of the rubber tree are carried in these 36 units; yield, growth, colour of latex, shape of leaves, susceptibility to disease, and all the other factors that we are interested in.

The budgraft is essentially a form of vegetative propagation. We first begin with a parent seedling tree, which has all the desirable characteristics. We start with bud-patches taken off its branches. Every cell of each budpatch carry the full complement of hereditary units, 36 in all. We graft these buds on prepared seedling stocks. When the bud has taken and the budded stump is planted out, the cells begin to multiply from the bud and a shoot is formed. One cell becomes two by a splitting of each of the 36 "hereditary units" to form two cells, each having the full complement of 36 hereditary units; two becomes 4 and so on until the mature tree is built up of thousands of plant cells which are genetically equivalent. The budgrafts from a single parent seedling tree can, therefore, be looked upon as "branches", which have grown from the buds on the bud-patches. Such a collection of budgrafts from a single tree is called a "Clone". In practice, however, this form of propagation to obtain "clones" from high-yielding seedling trees has its limitations. In many instances budgrafting from a high yielding seedling tree fails to reproduce the high yielding characteristics in the vegetatively propagated progeny in the first generation. The reason for this is not clearly understood. When a high yielding budgraft has been once established, however, the further propagation of the clone with 'secondary' budwood from nurseries has proved successful. The diagram I given on vegetative propagation makes the principle of transmission of hereditary characters clear as discussed above, taking for an example of vegetative or ordinary cell division only 4 "hereditary units", keeping in mind that a rubber tree has 36 such units.

When we consider clonal seed we have quite a different phenomenon in cell division compared with cell division in vegetative reproduction. The formation of seed is a sexual process. We are all familiar with the two generative cells which combine to form a seed. On the male side we have the pollen grain and on the female side we have the unfertilised embryo or "ovule". In the rubber tree both the male and female flowers are formed on the same flowering branch, but the crossing or fertilisation generally takes place between two clones and crossing within clones is the exception. When the pollen grain is ready to cross, the number of "hereditary units" is just half the number of the original 36. Each pollen grain has just 18 hereditary units, or chromosomes introduced at random. This is the specialised "reduction division" in diagram 2, from 36 units to 18 units. We thus have thousands of ripe pollen grains ready to fertilise the female flower each containing a different random lot of 18 hereditary units of the parent tree.

A similar reduction process occurs on the female side, and the unfertilised female "seed" embryo or "ovule", when it is ready to receive the pollen, has only half the number 18 in each ovule from a total of 36 grouped purely on chance. In the combinations different groups of 18 units from both male and female combine to form 36 "hereditary units" which form the seed. It is obvious that even the 3 seeds in each pod are therefore, genetically dissimilar. This is the most important point in understanding the nature of clonal seed. The diagram 2 on the "reduction division" in the sexual phase will make this

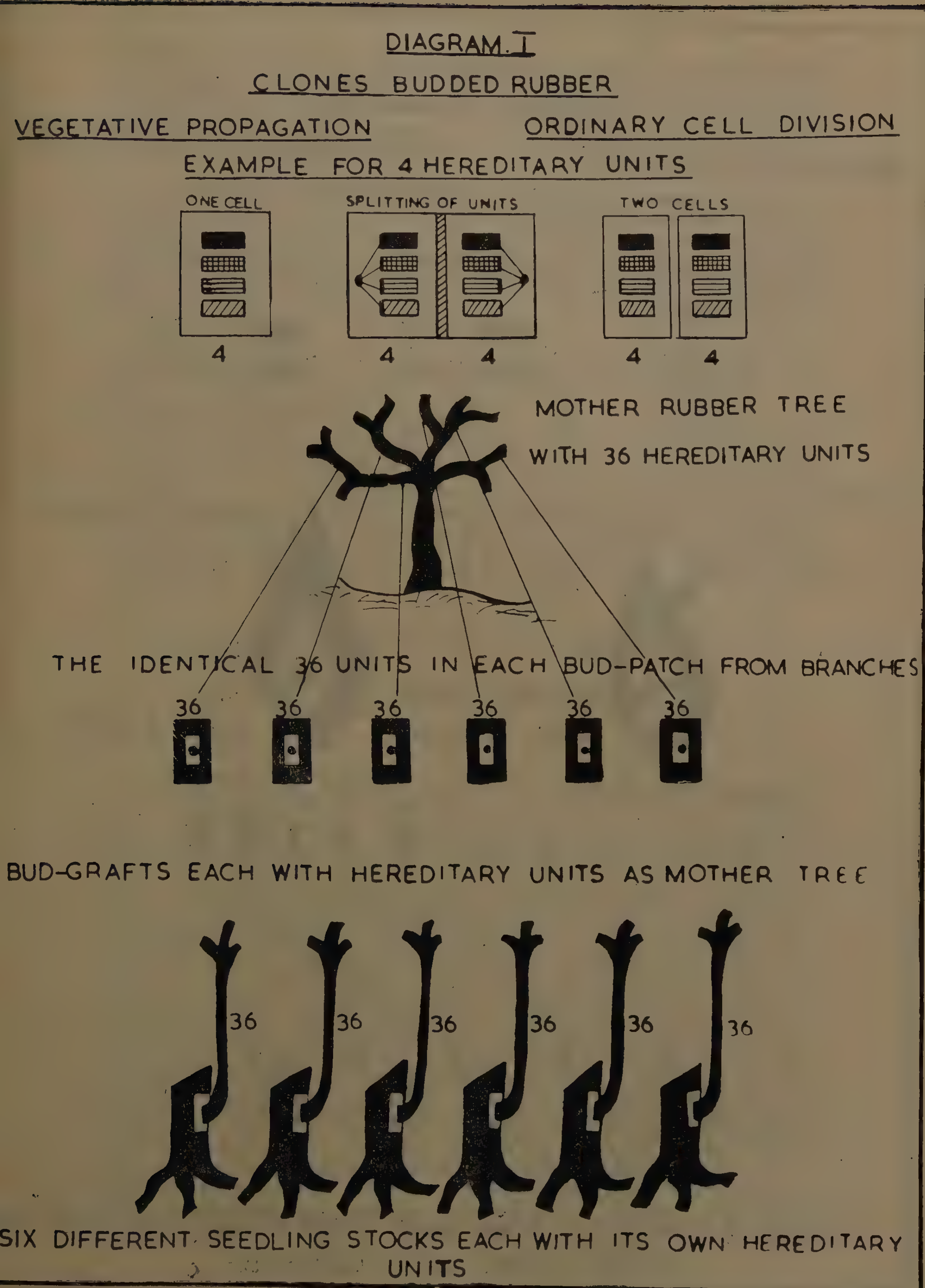
DIAGRAM. I
CLONES BUDDED RUBBER
VEGETATIVE PROPAGATION
ORDINARY CELL DIVISION
EXAMPLE FOR 4 HEREDITARY UNITS
ONE CELL
SPLITTING OF UNITS
TWO CELLS
4
4
4
4
4
MOTHER RUBBER TREE
WITH 36 HEREDITARY UNITS
THE IDENTICAL 36 UNITS IN EACH BUD-PATCH FROM BRANCHES
36
36
36
36
36
36
BUD-GRAFTS EACH WITH HEREDITARY UNITS AS MOTHER TREE
36
36
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36
36
36
SIX DIFFERENT SEEDLING STOCKS EACH WITH ITS OWN HEREDITARY UNITS

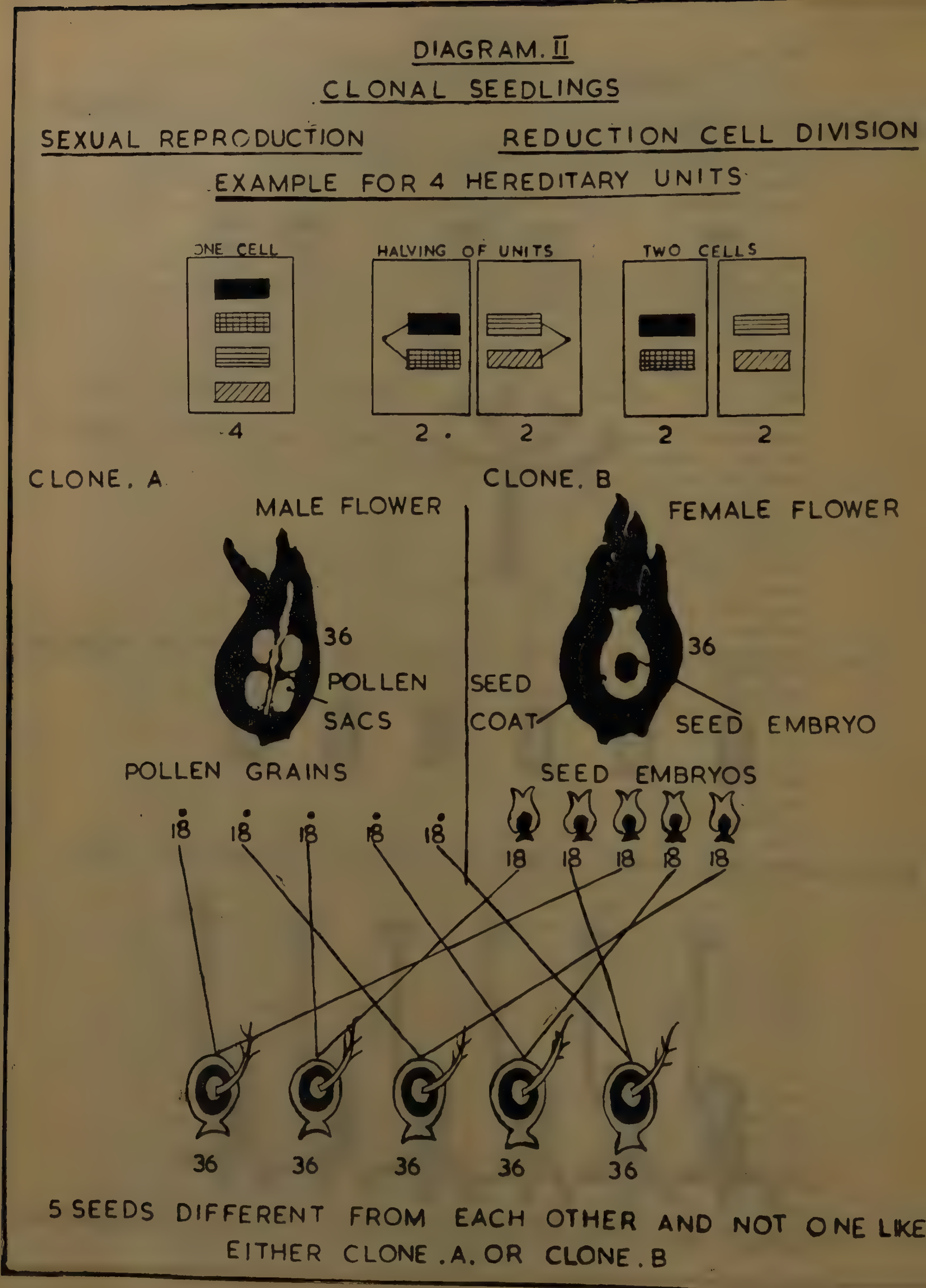
DIAGRAM. II
CLONAL SEEDLINGS
SEXUAL REPRODUCTION
REDUCTION CELL DIVISION
EXAMPLE FOR 4 HEREDITARY UNITS
ONE CELL
HALVING OF UNITS
TWO CELLS
4
2
2
2
2
CLONE. A
MALE FLOWER
36
POLLEN
SACS
POLLEN GRAINS
18
18
18
18
18
CLONE. B
FEMALE FLOWER
36
SEED
COAT
SEED EMBRYO
SEED EMBRYOS
18
18
18
18
18
36
36
36
36
36
5 SEEDS DIFFERENT FROM EACH OTHER AND NOT ONE LIKE
EITHER CLONE. A. OR CLONE. B

clear. In the case of clone A and clone B, acting as male and female parents respectively, no two seed formed from random aggregation of 36 units are equal in hereditary qualities, and not one seed will have the same group of 36 units as found in the male or female parent. Only 5 seeds are represented for an unlimited number of crosses possible in a single seedling season.

Fortunately the seed coat is a part of the female parent clone B in diagram 2, and has nothing to do with the fertilised embryo in the centre. We, therefore find that seeds of a single clone like TJ. 1 are similar in seed-coat characteristics and can be identified as such, but not a single seedling from a collection will have 100% of the characteristics of clone TJ. 1. In general no two clonal seed whether it is fertilised within the same clone or between clones are similar in all hereditary characters.

We have, therefore, established the fact that while budgrafts within the same clone have the same hereditary characters; no two seed from a single clone are equal in hereditary characters.

The practical implications are quite clear. The clone or a collection of budgrafts which is genetically equivalent tree to tree is the more reliable planting material. We can have one acre of clone PB86, with the desirable characters of high yields, good growth, and resistance to disease potentially present in every tree represented by the scion or bud-shoot. Unfortunately the reputation of a clone for high yields is not the only factor which contributes to high yields per acre. There are many other factors, which have a profound effect on growth and yield.

1. Type of stocks used for budgrafting.
2. Stand of trees per acre.
3. General agricultural practice including manuring.
4. Disease control.
5. Tapping system.

The variability of clonal seed from a single clone presents us with the difficulty of the choice of high yielding seedlings. A collection of seed of one clone may give 20% high yielders; a collection from another may give 50%. Mixed seed from two or more clones will also show marked variability in the production of high yielding seedlings and desirable secondary characters. By directly planting various "types" of clonal seedling and by hand pollinations, where both parents are known, we will be in a position to distinguish the many clones as good or unreliable clone parents. In other words some clones impart to their progeny the high yielding and good growing characteristics to a greater extent than others: we are, therefore, in a position to exploit the high percentage of high yielding seed from certain clones or groups of clones, by planting at a high initial stand per acre. Selective thinning out of undesirable trees is then carried out in stages, first on growth during the early years and finally on early yields, and secondary characteristics. Initial stands of 200 to 300 trees per acre, depending on the type of seed used are finally thinned out to about 180 trees per acre as for a stand of budded rubber. Such a stand of the best type of clonal seed will give yields equivalent to or even better than the best high yielding clones of the present day. "Selfed" seed of clone TJ. 1 and PBIG seed have come up to the standard of budded rubber, with little or no thinning out in clonal seedling areas in Ceylon. Higher initial stands and selective thinning will ensure yields of well over 1,500 lbs. per acre per year. The limited potentialities of the poorest "types" of clonal seedlings can be exploited in this way.

It is, therefore, obvious that clonal seedlings must be planted well above the stand required for permanent tapping throughout the economic life of a plantation.

An experiment comparing "types" of clonal seedlings was planted out at Dartonfield in 1947.

Four types of clonal seed including seed of clone PB86 and TJ. 1 are compared with budded material of clone TJ. 1. All seedling types, and the budded rubber were planted at 260 points per acre. In July 1951, the seedling trees were tapped on the Morris Mann system of early tapping and selectively thinned out to 160 points per acre on growth and yield characteristics. The budded trees were also thinned out purely on girth measurements leaving 160 points per acre of the best grown trees.

Each "type" of seed and budded TJ. 1 are represented in this experiment by 30 tree plots replicated eightfold after selective thinning out. The yields given under show that clonal seed thinned down from 260 per acre to 160 points per acre compare very favourably with budded rubber reprsented by clone TJ. 1. The results are given in Table 1.

TABLE I

| | TJ. 1 "selfed" seed | PB86 Illeg. seed | PB5/139 Illeg. seed | Hand-pollinated seed | Budded rubber Clone TJ. 1 |
|---|---|---|---|---|---|
| Yield in grams of 5 tappings Morris-Mann tapping at 4 years (1951) | 24.1 | 18.2 | 30.4 | 29.8 | Not tapped |
| Tapping of mature trees in grams/tree/tapping (1952) | 10.0 | 8.5 | 14.8 | 15.1 | 19.5* |
| 6 months 1953 | 10.5 | 11.2 | 15.5 | 15.9 | 12.3 |
| 1953 yields as per cent of budded control | 84.8 | 90.4 | 126.0 | 129.0 | 100% |

* Tapped from Sept. to Dec. 1952.

Firstly there is a strong relationship between the early yields of the immature trees and yield of the mature trees in the first year of tapping, which continues in the first 6 months of the second year. The correlation figures indicating this relationship between early Morris-Mann yields and those of the mature trees on a per tree basis range from .55 to .69 for the four types of clonal seedlings. These are significant statistical figures, although of a lower order than those obtained in Malayan experiments.

The figures indicate that the prediction of the yields of the mature tree from 5 tappings taken when the tree is at about 4 years of age is satisfactory for the early years of commercial tapping.

The figures also show that with selective thinning, yields equal to or better than the control budded TJ. 1 have been achieved in the early years of tapping. Similar results have been obtained in outside countries with many "types" of recommended clonal seedlings.

This method of selective thinning out on early tapping on the Morris-Mann system is useful with high initial stands of seedlings. It is feared that many estates will not undertake this somewhat elaborate system under estate routine, and thinning out on growth alone may be adopted with moderately high stands of rubber. Where areas are thinned out to stands of 200 or under on growth, the test-tapping for a preliminary elimination of about 10 per cent of the stand can be carried out during the first year of tapping.

For this particular purpose it will be feasible to tap the trees, when 75% of trees have attained a girth of 18 inches and over. A field officer with the aid of the tapper could easily mark out the poorest yielders for elimination. The tapping intensity for the first 2 to 3 years can be satisfactorily kept at a 67% intensity on a half spiral, third-daily system. It is an easy matter to adopt the normal 100 per cent "tapping on the alternate day half spiral on the same tapping task when required.

In this method a certain amount of competition in growth is inevitable after the fourth year of growth. Seedlings can, however, be tapped at the end of 5 years, if the trees of 18 inches girth and over are tapped on the reduced intensity of 67%.

Our present recommendations on planting material are based on small scale experiments carried out at our experimental stations and results obtained from commercial plantations which have been presented in our quarterly circular publications. Foreign clones, which have already given promising results and have been recommended for planting on a large scale in their countries of origin have not been tested to the same extent as local clones, but the results are sufficiently convincing to warrant recommendations for large scale planting in this country.

The recommended material is divided into 3 groups:—

Clones in Group A are the older high yielding clones, which continue to give satisfactory yields, and the newer clones and clonal seedling types, which are giving promising yields in this country compared with the older clones. Clones in group B have given promising results in experimental plantations compared with standard local and foreign clones; these can now be planted on a small scale. The groups C clones are those which have given promising yields in trial plantations, but information is still insufficient to justify their use on more than a trial scale. Clonal seedlings are recommended for use in groups C and A as an alternative choice of planting material. 80% of the total acreage in a comphrehensive replanting programme should be allotted to a selection of planting material in Group A. The planting material in groups B and C can be tried out on the remaining 20% of the total acreage; in general 2 acre blocks for a selection of clones and clonal seedlings in Group C.

No clone is without some defects, and it would be unsafe to generalise on most clones in any group to suit all conditions of growth in this country. Perhaps the exception to this is clone PB 86 which has done well in a variety of planting conditions. There is little doubt that all recommended planting material in Group A, B, & C will make substantial contributions to high average yields per acre, provided the planting is carried out according to recommendations and in keeping with high standards of agricultural practice.

It is possible that under specific local conditions in a particular rubber planting district a clone in Group B or C may do better than the best of clones in group A: under these circumstances there is no reason, why such a clone

should not be planted on a large scale on a particular estate. The recommendations made in the three groups need not be rigidly adhered to in any planting programme.

All recommended high yielding material is more or less susceptible to Oidium Heveae, and it is understood that the expected standards of yield will not be obtained, unless the recommended control measures and cultural operations are adopted.

Clone LCB 870 is resistant to Oidium, and although the clone can be mildly infected there is no leaf fall due to the incidence of disease at any stage during the susceptible period. Clone LCB 870 is not a high yielding clone, and its limited capacity for yield must be exploited to the best advantage because of its resistance to Oidium. Our knowledge of this clone is based on 24 trees about 13 years of age in the Matale district. The clone in its country of origin was not known as a high yielder, the limited yield data from tappings carried out in the 12th and 13th years of growth in Ceylon confirm this finding. It is known that about 70 trees of clone LCB 870 will be ready for tapping in the next year on a local estate in the wet low-country districts, and we will be in a position to check its performance under the more normal rubber growing conditions in this country.

From the limited data available we can tentatively state that the clone can yield about 5 lbs dry rubber per tree per year. It would, therefore, be possible to obtain economic yields from a tappable stand of about 150 trees at high elevations where only yields of about 250 lbs. per acre per year have been obtained hitherto from the best high yielding clones infected with Oidium. There are two disadvantages to encounter at these elevations namely high incidence of Oidium and poor growing conditions: both factors have a strong interaction on each other. If crown-budding with clone LCB 870 proves successful, this procedure will be largely used at the lower elevations with the best of high yielding clones. Sizable acreages of clone PB86 have already been crown-budded on many estates in districts where Oidium infection is heavy.

In any planting programme it is better to spread the risk by using more than one type of planting material. There is always the possibility of a clone developing an unforeseen defect during its economic life of 35 to 40 years. We, therefore, recommend the planting of any one type in group A on not more than 20% of the total acreage. In the case of clone PB 86, which has given the best results under a variety of planting conditions, the total acreage may be increased to 50 per cent based on the performance of the clone on any particular estate.

The recommended clones in the three groups are given below:

GROUP A—To be planted on 80% of total acreage.

BUDDED RUBBER. Clones PB 86, AV 255, PR 107, WG 6278, MK 3/2 RR. 501, GL. 1.

CLONAL SEEDLINGS Selfed seed of clone TJ. 1 and Prang Besar Isolated Garden seed from Malaya.

GROUP B. To be planted on 20% of the total acreage inclusive of Group C; normally about 5 acres of each clone selected.

BUDDED RUBBER. . Clones NAB. 12, 15, 17 & 20, LCB 1320, RRI. 513, PB. 5/60, RLD. 1.

GROUP C. Normally about 2 acres of each selected clone or type of clonal seedling.

BUDDED RUBBER. Local clones RLD 2, to RLD 14. Foreign clones IR 7, IR 10, PB 6/5, OE 1.

CLONAL SEEDLINGS. From approved sources or estates with a knowledge of the predominating seed parents in collections planted out.

**Clone PB. 86.**—The reliability of this clone under various conditions of growth in this country has been confirmed on most estates. The clone was established in 1923 on Prang Besar and it has had nearly 10 years of testing in commercial plantation in this country. As a control in our experimental plantations it has come up to the standard of the highest yielding newer clones both local and foreign. The clone is capable of yielding 17 lbs. dry rubber per tree per year, under local conditions. We have still not had extensive tapping experience on renewed bark.

**Clone AV. 255.**—This clone was established in Sumatra in 1927 from an illegitimate seedling of clone AV. 36. It is the highest yielder among the foreign clones planted in the 1940 clearing at Nivitigalakele. In the 6th year of tapping the clone has given 15 lbs. dry rubber per tree per year. The clone is recommended for large scale planting in Indonesia. 1000 lbs. per acre have been obtained on small acreages in commercial plantations in Ceylon in the early years of tapping.

The clone is best planted in somewhat sheltered areas.

**Clone PR. 107 (LCB 510).**—This clone, which was established in 1923 in West Java, has also been recommended for large scale planting in Indonesia. It is not classed among the highest yielding clones, but has very desirable secondary characteristics. In our experimental plantations it has given 10 to 11 lbs. dry rubber per tree per year in the 6th tapping year. It is partially resistant to Oidium, and is a hardy grower. Bark is thick and renewal is excellent. 1000 lbs. per acre have been obtained in commercial plantations in this country in the early years of tapping. It is a useful clone for the Galle and Matale districts. The clone is particularly suited for "avenue" planting.

**Clones MK. 3/2 and WG 6278.**—These two local clones have been considerably tested in this country. Clone MK 3/2 is the better yielding clone of the two and under normal growing conditions it can yield 10 to 12 lbs dry rubber per tree per year from the 4th year of tapping. Clone WG 6278 should not be planted on poor soils. In general it is strongly susceptible to soil conditions, and gives moderate yields except on the best soils, where average yields up to 10 lbs per tree per year can be obtained. Both clones are reliable clone parents and will be useful constituents of future seed gardens.

**Clone RR. 501.**—This Malayan clone has given an average yield of 17 lbs. dry rubber per tree per year from 78 trees planted in 1941 at Dartonfield in the 5th year of tapping. The results strongly confirm the high yielding characteristics in its country of origin. The clone has given 14 lbs. dry rubber per tree per year in our 1940 clearing at Nivitigalakele in competition with other foreign and local clones in a polyclone plantation. The clone was established from a seedling cross of clones PIL. A. 44 and LUN. N, and is considered the best of the "500" series in the Rubber Research Institute of Malaya. These early

indications of the high yielding capacity of the clone is considered sufficient to support our present recommendations for the large scale planting of this clone.

**Clone RRI. 513.**—This clone of the "500" series has not come up to the standard of clone RRI. 501 in the same polyclone area of foreign clones planted at Nivitigalakele in 1940. The clone is yielding 11 lbs dry rubber per tree per annum in the 6th year of tapping against clones TJ. 1 and WG. 6278 as controls giving 8 and 10 lbs. respectively. The clone is recommended for planting on a small scale, until further yield data are available.

**Clone Glenshiel 1.**—This clone remains one of the highest yielding clones in the near east rubber growing countries. It is sensitive to tapping intensity, but it can be successfully tapped on a 67% intensity in Ceylon yielding up to the standard of other high yielding clones tapped at 100 per cent intensity. Apart from its characteristics for an unstable condition of preserved latex, it is satisfactory for other forms of marketing rubber. The tree has a sparse foliage canopy, and is particularly well adapted for planting in exposed areas.

**The NAB. Clones, 12, 15, 17, and 20.**—These clones were established locally from selected Tjikadoe seedling mother trees on Nabunnatenne Estate. The original budgrafts were planted out in 1939 and 20 trees of each clone have been tapped for 8 years. The yields of these clones range from 14 to 18 lbs per tree per year against clones PB86 and MK 3/2 as controls, which have given 17 and 12½ lbs. per tree per year respectively. These clones are well worth a trial on a small scale on estates. Five acres of each of these clones will make useful contributions to the average yields from high yielding clones on any estate. At the same time one or more of these clones may be particularly adapted to local conditions in preferance to the older clones recommended for large scale planting.

**LCB. 1320.**—This clone under the name CHM. 2 was planted in Ceylon as early as 1938. There is little doubt that the clone has a reputation for high yields in its country of origin. The R.R.I. Ceylon, was unable to officially authenticate the clone CHM 2 as LCB. 1320 until about 1946, when the clone was planted on a large scale clonal trial at Nivitigalakele. The clone has been brought into tapping in 1953, and the early yields are satisfactory. Unfortunately, no estate has been able to give us authenticated yield data of commercial plantations over a period of years. First year tapping results are available on a 20 acre estate block and the early results are satisfactory.

**Clones IR. 7 and IR. 10.**—These two Indo-China clones were yielding 9.4 lbs. and 12.3 lbs. dry rubber per tree per year respectively in the second year of tapping against clones GL. 1 giving 6.6 lbs. in the same trial, in Indo-china. These clones are growing on better soils generally in their country of origin compared with Ceylon, nevertheless their early potentialities warrant a quick propagation and planting of the clones in this country. We are planting these clones out in 1954 on a large scale and budwood will be available in small quantities about the end of 1954 for trial on outside estates.

**Clone RLD. 1.**—This clone which was established from a local estate mother tree in 1940 is now yielding 12 lbs. per tree per year in the 6th year of tapping against control clones TJ. 1 and WG 6278 yielding 8 to 10 lbs. in the same clearing. It has no undesirable secondary characters and is worth a trial on a small scale on estates.

**Clone PB 5/60.**—This clone has been tapped for 8 years in a small scale trial with 28 trees. The clone has given over 10 lbs. per tree per year and is recommended for a small scale commercial planting.

**Clones RLD 2 to 7.**—These are selected local clones established from Prang Besar Seedlings imported in 1932. A clone trial with 75 trees of each clone was planted out in 1945 and the early tapping results of these clones in 1953 are most promising. Budwood of these clones will be available for small scale trials in 1954.

**Clones RLD 9 to 14.**—These are high yielding 5 tree local clones established from the 1939 hand pollinated crosses. The clones are the first selections from 110 clones in test-tapping and are yielding 13 to 16 lbs. dry rubber per tree per year. Each of these clones are now planted on 6 acre blocks, and it is essential that estates plant the clones out on a small scale for confirmation of results under various rubber growing conditions. Budwood will be available in 1954.

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## QUESTIONS & ANSWERS

YIELDS OF CLONE LCB 870.

MR. CYRIL DE SOYSA.

*Question.*—Considering the remarkable growth and satisfactory yield of clone LCB 870 in the higher elevations as reported in the 3rd and 4th Quarterly Circulars for 1952—why should it not be recommended for large scale planting in the low country where Oidium is now the most serious problem facing the rubber industry?

*Answer.*—The article in the Quarterly Circular publication referred to, gives satisfactory yields for LCB 870 compared with the poor yields obtained from high yielding clones severely attacked by Oidium. Clone LCB 870 is not a high yielder. The writer also states that "Yield results from such a small area are of course necessarily suspect and can only be taken as a rough guide". We have little or no experience of the growth or yield of the clone in the wet low country districts, we can, therefore, recommend the clone for planting on a restricted scale under special conditions for the present.

MR. L. C. DE MEL.

*Question.*—"Please tell us the actual yields you harvested from 24 trees of clone LCB 870 for any one year and the system of tapping."

*Answer.*—Since the clone LCB 870 has been found to be resistant to Oidium, the 24 trees on Kepitigalla estate have been tapped on and off during the past 4 years. No complete results for a single year are available.

In 1952 the available Estate yields from September to December on S/2, D/2 100% tapping worked out at 5.8 lbs. dry rubber per tree per year. This yield is on the high side, due to the fact that the last quarter of the year is the best yielding period. The test-tapping of these 24 trees in 1953 in the 13th year of growth was supervised by the Botanical Department. Up to the end of

September the yield was 3.8 lbs. dry rubber per tree per year. An improvement on this figure can be expected by the end of the year.

## GENETICS.

Mr. Huntley

*Question.*—What is the insect that pollinates the female flower of Hevea?"

*Answer.*—In recent years "Warinka" working in Puerto Rico states that pollination is generally done by "midges" of the family Heleidae; to a lesser extent by thrips. This suggestion, however is by no means a final conclusion.

## STOCK-SCION EFFECTS

Mr. Huntley.

*Question.*—"Generally speaking which parts of the mature budded tree do the scion effect or dominate and what the stock".

*Answer.*—Mr. Huntley has also asked several other questions which require highly technical details of plant anatomy, which is clearly beyond the scope of this Conference.

In general we can say that there is ample evidence from experiments carried out in Malaya, Indonesia and Ceylon to show that there is considerable stock-scion and scion-stock relationship.

Indications given by correlations worked out between yield and growth factors of stock and scion show that this relationship is most marked, nearer the union. For example in high bud-grafting experiments yield is influenced more markedly immediately above and below the union and the influence of stock and scion become less marked or absent as the points of investigation recede from the union upwards and downwards.

Mr. Huntley.

*Question.*—"Why is TJ. 1 "selfed" seed the best type for stocks?"

*Answer.*—"Selfed" seed of clone TJ. 1 can be expected to produce a high percentage of vigorous high yielding seedling. Both the vigour of growth and high yielding characteristics of stock seedlings associated with a clone (scion), which is selected for good growth and high yields will give the best results.

## PHYSIOLOGY OF LATEX PRODUCTION.

Mr. E. C. K. Minor.

*Question.*—"It is known that the formation of latex is closely linked up with the growth of the plant, so further information would be of great interest."

*Answer.*—When a tree is tapped the normally formed rubber is taken off, more rubber has to be regenerated. This regeneration requires energy which is taken at the expense of translocated carbohydrate reserves. For growth the rubber trees call on the same food reserves and therefore yield is taken at the

expense of growth. This effect is more marked on young trees when growth is an important factor.

## CLONE IDENTIFICATION.

Mr. Alban E. Wijesekera.

*Question.*—"Has it now been proved beyond all reasonable doubt that the clone known in Ceylon as CHM 2 is the very identical (vegetative) progeny of the clone LCB 1320?"

*Answer.*—We have identified clone CHM 2 as clone LCB 1320 from authenticated seed of clone LCB 1320 brought over from Indonesia.

## PLANTING DENSITY.

Mr. Alban E. Wijesekera.

*Suggestion.*—The number of budded plants to the acre has been steadily rising from 120 to 180 or 200. I would agree with the enchanced density, and I would go further and say that in my opinion 250 or even 300 budded plants to the acre as initial planting is not too high.

*Answer.*—The maximum density cannot be fixed on yield alone. In a Malayan experiment 222 trees per acre was the most economic stand during the early years of tapping, comparing stands per acre ranging from 48 to 435 trees per acre. In an Indonesian experiment more than 160 trees per acre at the end of the 3rd year of tapping with a mean girth of 26″ was the maximum and the stand had to be reduced to obtain adequate bark renewal.

High stands of rubber strongly affect the rate of growth and under Ceylon conditions a final stand of about 130-140 trees will be best for the middle years of tapping, coming down to about 90 to 100 in 20 years.

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# GENERAL QUESTIONS

## PLANTING BUDDED STUMPS

Mr. F. G. C. Bushby.

*Question.*—"The 6″ just above the union of a budgraft does not yield as well as high up on the tapping panel".

*Answer.*—The yield 6″ above the union will depend on the stock. Poor stocks will depress the yield.

*Question.*—"In planting budded stumps would it not be advisable to use 3ft. deep holes or more and only fill up 6″ from the top of the hole?"

*Answer.* 1. There is always the question of waterlogging of holes before the "snag" heals over.

2. The low cuts are influenced by an area which goes beyond the limits of the union, even if this area is underground.

3. The surface lateral roots are not well adapted to feeding below the normal surface soil level even if the procedure prevents some root exposure.

4. Budgrafting almost at ground level, greatly improves the level of union with normal planting.

GENERAL.

Mr. D. P. Thrimavithane.

*Question.*—"What clone may be most suitable for virgin land where rainfall is heavy and wind is strong?"

*Answer.*—We do not differentiate clones as suitable for virgin or replanted land; the growth and yielding qualities are hereditary and selected clones should do equally well, on both types of soil. Clones Glenshiel 1 and PB86 will be suitable for areas of high rainfall with strong wind.

# FOMES LIGNOSUS IN REPLANTED AREAS*

BY

**Dr. A. Newsam**

**Head of the Pathological Division, Rubber Research Institute of Malaya**

The chief concern in replanting is to establish the desired stand with a minimum of expense, which means also the minimum demand on available labour. It is not reasonable to regard pest and disease work as justified only in times of prosperity and not in times of financial stress. The most economical solution of the root disease problem will always be the same though it may sometimes be necessary to defer for a limited period some part of the work on control, or to spread it over several years. The account which follows falls broadly into three parts dealing firstly with the facts about the fungus, secondly with what may be regarded as the ideal way of dealing with root disease, lastly discussing certain expedients by which the desired end may be achieved perhaps more slowly but also more cheaply.

The dominant fact about White Root Disease is that infection of trees in a replanting arises by contagion, when roots of the young stand come into contact with a diseased root or stump. The whitish root-like strands of the fungus (the rhizomorphs) spread along the healthy tree roots, which are then penetrated by the fungus and killed. As far as is known no other method of infection of healthy trees can occur. If the old stand had root disease in it, and the stumps are left in the ground, then infection will spread to the young trees from these sources. Even if there is no sign of disease in the old trees when they are felled, their stumps will sometimes be found later to be sources of infection. This has been interpreted as showing that *Fomes lingnosus* can remain dormant on old trees. There is reason to doubt the theory and to suppose instead that the stumps become infected after felling, by windborne fungal spores. The orange-yellow bracket-like fruit bodies of the fungus are commonly seen round the bases of trees in an advanced stage of decay, and they produce spores in abundance. There is, moreover, some direct evidence of spore infections of moribund stumps and also, though rarely, of branch and stem injuries, by *Fomes* species.

Evidence against the theory of dormant sources of infection was provided by an experiment carried out in 1948-9(1) part of the results of which are summarized in Table I.

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* This paper refers to Malaya and the views expressed are not necessarily applicable to Ceylon conditions.

(1) Rep. (Pathological Division) Rubb. Res. Inst. Malaya (1949) 5

Table I. *Influence of age and vitality of the host on the activity of Fomes lignosus*

| Degree of infection | Age of roots (years) | Period after inoculation | | | |
|---|---|---|---|---|---|
| | | 4 months | | 8 months | |
| | | Int | Sev | Int | Sev |
| Number of roots infected | 6 | 4 | 4 | 4 | 4 |
| | 20 | 4 | 4 | 4 | 3 |
| Mean length of epiphytic growth (inches) | 6 | 37½ | 20 | 41 | 70 |
| | 20 | 26 | 15 | 42½ | 70 |
| Max. length of epiphytic growth (inches) | 6 | 48 | 50 | 60 | 126 |
| | 20 | 48 | 31 | 60 | 102 |
| Number of roots penetrated | 6 | 2 | 2 | 3 | 4 |
| | 20 | 2 | 2 | 4 | 3 |
| Mean length of penetration (inches) | 6 | 7 | 23 | 35 | 61 |
| | 20 | 3 | 5 | 12 | 50 |

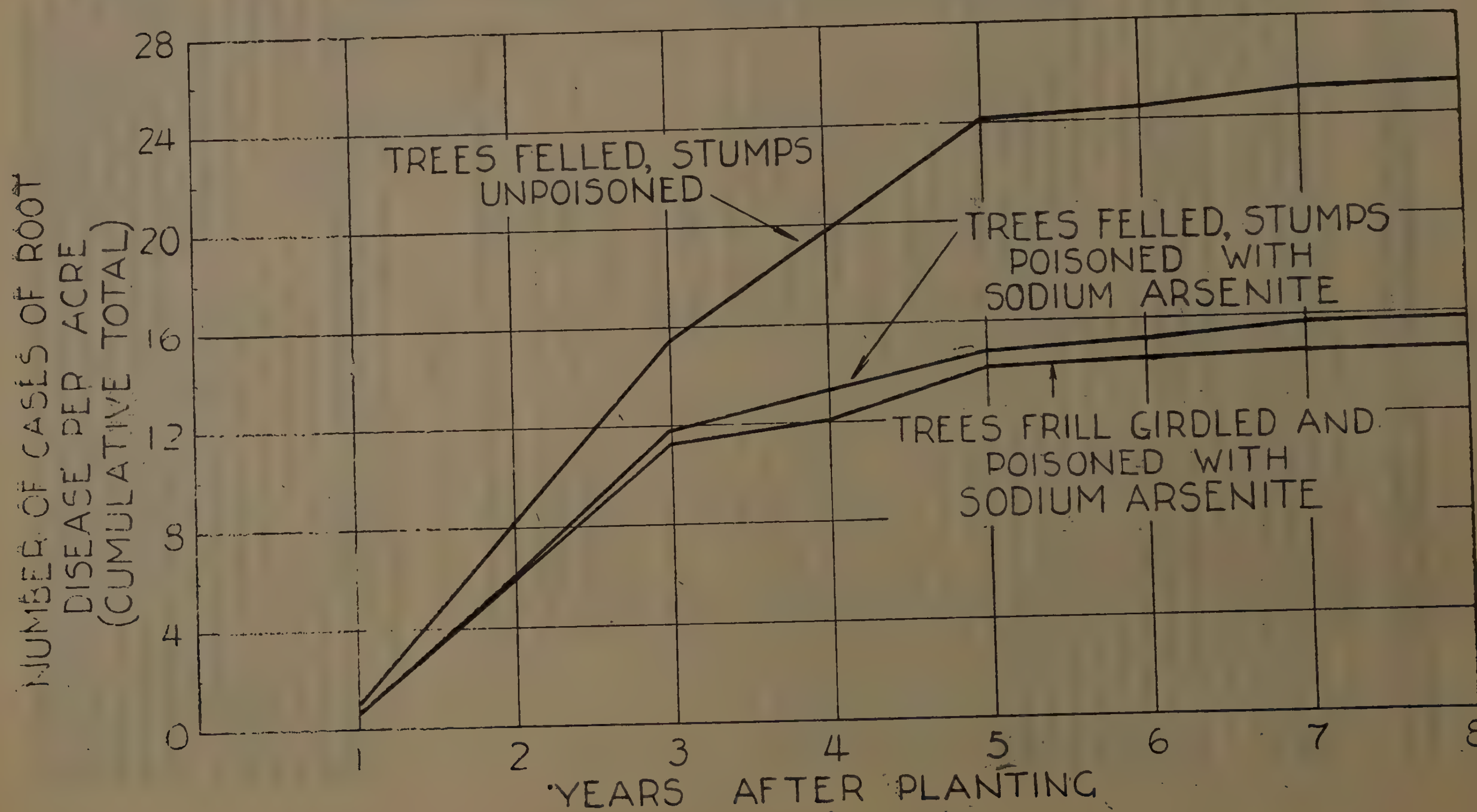
Int.=roots intact Sev=roots severed

In this experiment two roots on each of sixteen six-year-old trees and sixteen twenty-year-old trees were inoculated with pieces of naturally infected root, one of the two roots on each tree being first severed with a saw cut. The results quoted are for roots inoculated with *Fomes lignosus* and examined after four or eight months. There are indications that severed (and therefore moribund) roots are more quickly invaded by the fungus than are healthy ones, but no difference is established between the susceptibility of the young and the not so-young trees. It may be suggested that a difference might have appeared had there been a greater disparity in age of the trees, but against this is the common observation that disease patches due to *Fomes lignosus* continue to expand in the oldest rubber. The theory of dormancy is regarded as untenable. Trees of all ages are susceptible to attack, even if not equally so, and it may be supposed that the time taken to kill a tree is principally a function of the size of its root system. The data incidentally provide information on the rate at which the rhizomorphs spread, and the distance there can be between the limit of advance of the fungus along the outside of a root, and the limit of penetration in the wood. This has a bearing on the method of treating diseased trees, for it explains why a limited collar inspection enables many infected trees to be saved.

The foregoing remarks show that the root systems of all the old trees are a possible hazard to the young trees in a replanting. The fungus is already active in the roots of diseased trees; roots of healthy trees are a potential danger since they may later become infected. Total eradication of the old stand is clearly the ideal solution to the problem. Some root fragments will inevitably remain to start a few infections, but their removal is an easy matter and most will rot away without infecting anything. Another and generally more practicable way of achieving the same end is by eradicating the actively diseased trees, which will generally lie round the margins of well-defined disease patches (in the centres of the patches the fungus will have exhausted its reserves and died out) and so treating the healthy trees that their roots are no longer liable to infection. This is the purpose of tree or stump poisoning, the value of which in reducing the incidence of *Fomes lignosus* in a replanting was shown in a prewar experiment referred to as H.2 and described in RRIM Annual Reports for 1938-1946. The relevant results are shown graphically in Figure 1.

Figure 1

*Effect of three methods of clearing on the incidence of root disease in a replanted stand*



Incidence is plotted as cumulative totals, the curves flattening off because control measures were carried out. Poisoning with sodium arsenite either the standing tree or the stump after felling effected a 40% reduction in incidence on the young rubber. The treatments were applied to all trees whether initially healthy or diseased. It was concluded that poisoning had failed to destroy an infection already established but had "neutralised" the healthy stumps.

Observations which have since been made on the distribution of arsenic in poisoned stumps and on the arsenic tolerance of *Fomes lignosus* have supported the view that poisoning exerts its effect indirectly—by killing the roots quickly and thereby exposing them to invasion by harmless fungi to the exclusion of the parasites. The rate of death of lateral roots has accordingly been taken as a basis for comparing stump and tree poisoning procedures. The results obtained in one experiment have been published (1). The results of a second and more complete experiment are given in Table II.

TABLE II

*Effectiveness of stump and tree poisoning with sodium arsenite*

| Method of application | % lateral roots alive after a year |
|---|---|
| Stump poisoning | |
| — into auger holes | 1 |
| — after ring barking | 24 |
| — direct to the cut | 27 |
| Stumps untreated | 77 |
| Tree poisoning | |
| —after ring barking | 9 |
| —after frill girdling | 4 |

Sodium arsenite was applied in all treatments at a concentration of ten pound in one gallon of water. In the auger method six holes were bored, one over the tap root and five into the outside of the stump over lateral roots. The quantity of poison given was eight ounces per tree, as when the solution was poured into the fissure left in the cut surface of the stump or into the frill girdle on the tree. After ring barking the poison was applied as a paste made with tapioca flour, the average quantity being two ounces. While the prewar auger method of stump poisoning stands out as the most effective, its cost in labour and poison is against it. Ring barking is preferred as the cheapest effective method. Both methods of tree poisoning gave good results.

The intention in both experiments is to follow the observations on the old stumps with records of disease incidence in the replanted stand. Results recently obtained in the earlier experiment show the expected agreement between disease incidence and the survival rate of the roots of the stumps.

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(1) Archief Rubbercult. Special issue (May 1953) 122. Report of the Conference of Rubber Research Institutes in the Far East held at Bogor on July 15th-17th, 1952 (Agricultural part).

The magnitude of the root disease problem in a replanting and the cost of control measures depend very largely on the procedure followed in clearing the old rubber. The cost figures shown in Table III have been drawn up as a basis for discussion of the available methods of clearing. They must not be regarded as giving more than the order of magnitude in each case, as they depend so much on local conditions. The amount of labour required, expressed in man-days per acre, supposes a stand of sixty large trees. The costs in Malayan dollars include materials as well as labour, the last column showing the approximate conversion into Ceylon Rupees.

TABLE III

*Estimated costs of methods of clearing old rubber*

| Method of clearing | Man-days per acre | Total cost per acre | |
|---|---|---|---|
| | | $ | Rupees |
| Mechanical clearing | — | 250 | 400 |
| Winching and stacking | 120 | 250 | 400 |
| Felling and clearing | 60 | (125) | (200) |
| Stump poisoning | 2 | 10 | 15 |
| Tree poisoning | 2 | 10 | 15 |

Mechanical clearing is here taken to mean the use of heavy tractors and equipment, and includes winching the trees over, stacking, burning and rooting in two directions. The method can be employed only in flat or gently undulating land without danger of serious soil erosion. It would be impossbile in much of Ceylon's rubber land because of the steep slopes and rock outcrops. To be economic the heavy expense of moving the equipment must be spread over a large acreage, say not less than 300 acres; even then it is seen to be costly. Winching or jacking trees out by hand work costs almost as much to do a far less thorough job. More labour is expended in cutting, moving and stacking than in the felling operation. To deal with the whole stand in this way can hardly be justified but it is of value in clearing diseased trees at a cost of about two man-days each. Felling requires about half as much labour. Its cost has been shown in brackets because it will not be a charge on the estate if the timber is saleable as firewood. It should be followed by stump poisoning as already explained. Tree poisoning stands apart as by far the cheapest method of clearing.

Both felling and stump poisoning, and tree poisoning, have the great merit of being applicable anywhere without disturbing the soil. It is therefore not surprising that, apart from a few large companies who prefer mechanical clearing for reasons other than root disease control, the majority of Malayan estates either poison the standing trees or the stumps after felling. The choice between the two is often determined by the market for firewood though other factors are involved too—tree poisoning entails some damage to the young stand and may increase weeding costs.

Following either procedure the question arises as to when the diseased old trees can most easily be disposed of. On the face of it the task is best undertaken

when preparing the area for replanting, when work can proceed unimpeded and the trees can be felled in such a way as to bring much of their root systems out of the ground as they fall. On the other hand if eradication is postponed, to be carried out in the course of control in the young stand, the cost is spread over several years and the stumps will all the time be tending to rot away. The longer their removal can be delayed, the easier the work will be. A policy of replanting leaving diseased stumps still in the ground may sometimes be justified although it is bound to result in more young trees becoming infected. It is more likely to succeed in hedge or avenue replanting where the roots will be longer in penetrating the width of the interrows and so encountering all infective sources, than in more nearly square planting. In any case diseased stumps should be removed if they lie near the new tree rows. In the same way, when a stump is found to be a source of infection, its diseased laterals should be taken out where they approach the tree rows, even though the rest of the bole is left in the ground longer to rot.

The policy of leaving diseased stumps to rot will have a better chance of succeeding if the ground carries a dense creeping cover which will envelope them and hasten the process of decay. Legume covers have a further important influence on root disease. Experiments have shown an incidence on the young rubber where bush or creeping covers were planted of only half that in comparable clean clearings. The result is somewhat surprising since the covers were themselves susceptible to the same diseases. Two explanations of this effect have been proposed. The first supposes the rhizomorphs of the parasites to dissipate their reserves in spreading over the dense tangle of cover crop roots. The second atributes the effect to changes in the microflora of the soil under dense cover, encouraging the multiplication of fungi or bacteria that are antagonistic to the parasites. Though the question remains unresolved the practical point is that the cultivation of legumes has a most desirable effect. Bush covers, although they serve as indicators of sources of infection, must be eradicated when diseased—unlike creepers. Moreover they do not have the same beneficial effect in hastening the decay of surface timber.

Root disease control in replanting cannot be entirely separated from considerations of control generally. Regular inspection and treatment is essential in young rubber, otherwise such infections as occur—and there will almost always be some—will spread centrifugally to become in time the root disease patches that are such a familiar feature of old plantations. Tracing out and eradicating disease sources is bound to pay as a long term policy, viewing rubber as a continuous cultivation. It ensures that a full stand is maintained and also that, when the time comes to replant, *Fomes lignosus* will be of slight consequence, for it is seen that the problem at replanting is mostly concerned with the disposal of old diseased trees.

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## QUESTIONS & ANSWERS

**Mr. Farquharson** referring to the experiment to which Figure I relates enquired whether any record of the incidence of *Fomes* had been maintained prior to the experiment being laid out.

**Dr. Newsam** knew of no such record but pointed out that the top curve in the figure gave an indication of the amount of disease present.

**Mr. Farquharson** stated that it was the practice in Ceylon to remove all the old stumps from the site of a replanting; he wished to know how this procedure compared with poisoning from the point of view of root disease.

**Dr. Newsam** considered that it was a good practice to remove all stumps but that in Malaya the cost of doing so was frequently prohibitive.

**Mr. Bruce Foote** enquired about a certain clearing which was shown to him during his visit to Malaya. In this clearing poisoning had been practised. Was there any *Fomes* in it now?

**Dr. Newsam** said that this must have been a field in the hilly part of the RRIM Experiment Station at Sungei Buloh. There is *Fomes* in the area.

**Mr. Huntley** enquired about the effect of poisoning jungle stumps on the incidence of root diseases.

**Dr. Newsam** said that the experiment has been carried out before his time. There were indications of a considerable reduction in *Fomes* infections.

**Mr. Minor** asked whether any attempt had been made to discover a root system resistant to *Fomes*.

**Dr. Newsam** did not know of any work along these lines, further he considered the possibility of there being resistant root stocks to be remote. The formation of vacant root disease patches argued against it. Even if resistance were encountered it would be much more difficult to establish than resistance to disease in the aerial parts of the tree.

# SOME ASPECTS OF THE RELATION BETWEEN REPLANTING AND "MANUFACTURE"

BY

**E. J. Risdon, Chemist, with contributions by H. M. Collier, K. Wickham, K. J. Wilkin & Major J. H. Hoare.**

*Contents* *Page N.*



## Section 1. Introduction

The Rubber Research Board has decided that the basic theme of this conference shall be replanting and that each technical Department of the R.R.I.C. shall, as far as practicable, organise or assist in the organisation of a contribution showing inter alia how the work of the Department concerned is

related to the subject of the conference. It is desirable therefore to make it clear at this stage that, broadly speaking, the Chemical Department of the R.R.I.C. is intended to undertake advisory, development and research work on natural rubber latex after it leaves the tree and upto the stage of despatch by the Packing Houses, not the Estates, to the consumer. Very obviously this is a large field, (starting with the fresh latex and finishing with marketing of the bales e.g. technical classification, packaging etc.), which in the wealthier Research Institutes is covered by a qualified staff, numerically larger than that available at the R.R.I.C. Therefore it is not inappropriate to make it clear that the Department may, in general, be unable to undertake routine analysis of Estate raw materials e.g. acids, bisulphite etc. unless such analysis is likely to be of general interest.

Considerations of time and available facilities necessitate a clear-cut decision concerning the subjects to be discussed in this paper and it has been decided that, in general, this paper shall not deal primarily with typical process faults and their correction. Information on the latter subjects can usually be found by reference to the standard books, booklets, leaflets etc. In Ceylon the R.R.I.C. booklet "The Preparation of Plantation Rubber in Ceylon" by T. E. H. O'Brien, revised 1943 price Rs. 2/50, deals with many of the general principles and faults likely to be encountered in manufacture, and the scope of this booklet is extended from time to time as the information becomes available by leaflets, Advisory Circulars, Quarterly Circulars and Annual Reports all of which are available to registered Estates. The main text of this paper is divided into 4 further sections entitled (2) Choice of Planting Material from Manufacture Viewpoint (3) Increased Factory Output (4) Factory Services and (5) Marketing and Quality. The reasons for the choice of subjects are explained in more detail in the introductory subsection given at the beginning of each section. At this stage it is only necessary to point out (a) that the question "how far can manufacturing difficulties be allowed to influence the choice of planting material?" is partially discussed in section 2 and (b) that certain points arising from the question "how shall the extra crop be disposed of?" are discussed in section 3. In Section 4 certain aspects of the disposal of raw rubber factory effluents are mentioned. Section 5 deals with the more specialised subjects of marketing and includes an account of the technical classification of natural rubber.

To increase the value of this contribution to the conference papers various members of certain companies concerned with the Ceylon rubber planting industry have consented to write subsections describing either specialised equipment under their control or their views on certain problems which may be of general interest to Planters. Subsection 2(d) on the choice of clones best suited for the purpose of turning the latex into centrifugally concentrated latex for certain end-uses and subsection 3(d) on the procedure of latex concentration have both been written by Mr. H. M. Collier on behalf of Messrs The Latex Corporation of Ceylon Ltd. Subsection 3(b) describing the layout of a large blanket crepe factory in Ceylon has been written by Mr. K. Wickham of Messrs. Brown & Co. Ltd. with the full approval of Messrs. Carson Cumberbatch & Co. Ltd.

## Section. 2. Choice of Planting Material from the 'Manufacture' Viewpoint.

2. (a) Introduction: Advice upon the subject of the most suitable planting material for any given Estate conditions is primarily the province of the Botanist in the R.R.I.C. However it is not necessarily sufficient to consider

only the anticipated yield and disease resistance, and some thought may have to be given to the form in which the rubber obtained from the areas shall be sold by the factory. The price differential between smoked sheet, blanket crepe, sole crepe and the rubber in latex sold for concentration is not necessarily constant over long periods of time, at least in Ceylon and, ideally, the planting material selected should perhaps be such that the latex can be used with the minimum of trouble and expense for the production of any of the standard Estate products mentioned above. Where this ideal cannot be attained, the individual Estates will have to decide for themselves how far their choice of Planting material shall be influenced by these considerations. In this section it is proposed to discuss the subjects of the latex colour, precoagulation of latex intended for crepe and R.S.S. and latex for centrifugal concentration for certain purposes.

2. (b). LATEX COLOUR: At present, water-white or near water-white sole or blanket crepes normally command a significant premium over the lower grades of crepes. Although there can be a marked increase in colour with incorrect processing, the colour of the finished latex crepe in the absence of special processes is normally a function of the original latex and this in turn depends mainly on the inherent characteristics of the tree or clone. Although young trees, and trees that are tapped after a period of rest tend to produce yellow latex, certain clones such as PB.86 seem to have got a reputation, at least in Ceylon low country districts, for giving white latex and others such as TJ. 1 tend to give yellow latex in these areas. The R.R.I. of Malaya has listed certain clones in Malaya in descending order of latex whiteness. The list was prepared [C/M 55 (1950)] by examining a set of crepe specimens made from latices of the clones (of differing age) at the R.R.I.M. Experiment station. The list, which is reproduced below, should only be regarded as a rough guide, since trials elsewhere might place the clones in a slightly different order:

(Whitest) Pil A.44; RRIM.524, 512, 511, 502, 506; B.D. 5; RRIM. 513; PB.23, 86; AV.152; TJ.16; AV.50; RRIM.603; G.1; Pil.B.84; RRIM.602, 501; (Pale yellow) Lun.N; TJ.1; RRIM. 528; AV.49; RRIM.523, 526; PB.25; (Deep yellow) RRIM.527, 525, 529; PB.186.

Unreplicated tests at the R.R.I.C. arranged the NAB. clones listed in the descending order of crepes whiteness as shown below:

N.A.B. clones 20, 17, 15, 12 (yellowest).

The colour of the latex crepes made from a particular latex can usually be substantially improved by the well known process of fractional coagulation, whereby much of the yellow colouring matter of latex is, in effect, preferentially coagulated before the main bulk of the rubber. This process is carried out after the addition of the bisulphite (with or without the addition of a small quantity of acid as convenient), as is described in more detail in the literature, e.g. in 'The Preparation of Plantation Rubber in Ceylon' Revised Edition p. 42 and in various R.R.I.C. leaflets. When very yellow latex is involved the production of the top quality sole crepe may be either impracticable or economically undesirable due to the high proportion of the total dry rubber which has to be removed and sold as lower priced, yellow first fraction. At present this difficulty can to a considerable extent be overcome by the carefully controlled use of Messrs. E.I. Du Pont de Nemours' R.P.A. No. 3, which is used as a latex bleaching agent.

The bleaching action of R.P.A. 3 was discovered by the R.R.I. of Malaya and a patent application, B.P. 14700/50, was filed in 1950. This chemical

was introduced to Ceylon on a large scale in 1951-1952. R.P.A.3 contains about 36.5% of xylyl mercaptan, the active ingredient, and has to be emulsified in water before addition to fresh latex. The commercial and experimental emulsification procedures, using Duponol OS as emulsifying agent, have been fully described in the publications of the R.R.I.C. and of Messrs Mackwoods Ltd., the Colombo agents for the raw material manufacturers. The proportion of R.P.A.3 used on commercial Estates seems to vary between 2 and 20 ozs. of R.P.A. 3 per 1000 lbs. dry rubber in the latex, but in general no hard and fast rules are advised as the conditions e.g. degree of improvement in colour required, type of latex available, weather, tapping systems and quality of water etc. may vary from one Estate to the next. Estates have been advised to determine for themselves the quantities best suited to their conditions, bearing in mind that there is considerable evidence to show that an excess of R.P.A. 3 is usually unnecessary and frequently undesirable.

R.P.A.3 may, in theory, be employed commercially either to reduce the % of low grade fraction maintaining approximately the same overall appearance in the main bulk of the rubber, or to improve the product with approximately the same % of low grade fraction or a suitable combination of the two may be followed. The ideal of entirely eliminating the fraction (e.g. to make, say, blanket crepe just upto No. 1 grade) by the use of RPA.3 may be practicable in certain cases, but does not seem to be universally applicable. Further details on the use of RPA.3 are to be found in the form of a review article in the latest Quarterly Circular of the R.R.I.C., which is now (July '53) in the hands of the printer. Recently the manufacturers of RPA.3 have suggested that the material might more conveniently be supplied in a more concentrated form (concentrated RPA.3) containing about 82.5% instead of 36.5% of xylyl mercaptan. Concentrated RPA.3 would thus contain less kerosene type diluent and would have a specific gravity of about 1.04 instead of about .87. While concentrated RPA.3 would undoubtedly be slightly cheaper than the standard commercial product, it is by no means certain at present, since some Estates have only comparatively recently got used to RPA.3, whether the very small saving expected per pound of bleached rubber, as a result of the change-over to concentrated RPA.3 is sufficient to justify the risk of producing appreciable quantities of discoloured crepes through miscalculation of the quantities of concentrated RPA.3 required for the latex.

To summarise, where Estates propose to turn the maximum possible proportion of their rubber into top quality premium crepes, large scale planting of material likely to give a very yellow latex should perhaps only be undertaken if the extra yield (compared to a white latex material) is sufficient to overcome the risk that even with RPA. 3 a slightly higher % fraction may be necessary under their conditions to reach top prices when desired or that top prices cannot be reached at all. While there seems to be no doubt that (a) RPA.3 can at present be of great value to Estates, especially to those with large areas of some yellow latex clones such as TJ.1, and that (b) certain crepe Estates appear to have approached the point where they no longer regard the colour of the latex as such a major problem under their present normal conditions, the R.R.I.C. has not a sufficiently large area of yellow latex to indicate from personal experience on a large scale whether the carefully controlled use of RPA.3 can produce top quality, substantially non-discolouring, premium crepe from a very yellow latex without a marked increase in % first fraction. It is perhaps worthwhile warning Estates that they may be well advised to consult their brokers from time to time concerning the colour holding properties of their crepe.

2. (c) Precoagulation of Latex Intended for Crepes & R.S.S.: Latex from young trees and from the trees of certain clones, e.g. TJ. 1, AVROS.

49, has a marked tendency to precoagulation, that is coagulation in the field prior to arrival at the Estate's crepe or R.S.S. factory. This tendency may often be observed in the cups and buckets and can lead to complete coagulation during transport to the factory. Lumps of precoagulum removed from the the cups, buckets etc. can normally be made neither into good quality R.S.S. due to milling difficulties with the standard R.S.S. mills, nor into good quality crepes, due to streakiness and rapid discolouration in the absence of sodium bisulphite. Precoagulation is usually worse in wet weather.

On the suggestion of the Sabaragamuwa P.A., the R.R.I.C. recently carried out with the assistance of the Superintendent at Pelmadulla Group, Kahawatta, some experiments on the prevention of precoagulation of TJ. 1 latex and these experiments will in due course be included in an article in the Quarterly Circulars. Since the % precoagulation over the TJ. 1 area at one of the divisions of this Estate has been very considerably reduced by the Superintendent from a figure of about 15%, inspection of the area concerned, if this can be arranged, might be of value to Superintendents still in difficulties over this subject. For practical purposes there appear to be two major processes involved in the natural coagulation of latex, firstly an enzyme destabilisation process probably leading to alteration of the protein stabilising layers round the rubber particles in the latex and subsequent partial or complete coagulation of the yellow fraction, that is the lutoids, Frey-Wyssling particles and associated rubber; secondly, bacterial action leading to the production of acids and thence to destabilisation by neutralisation of the electric charge on the particles. Probably the relative importance of these two processes depends upon the individual conditions involved at the time. For further details on the basic principles underlying this subject reference should be made to the literature e.g. R.R.I.M., R.R.I.C. circulars and reports, and various numbers of the R.R.I.M's Planters' Bulletin New Series etc.

The preferred anticoagulants are mild alkalis, such as sodium sulphite, ammonia, sodium carbonate, or certain bactericides such as formaldehyde with or without the addition of an alkali. Washing soda and soda ash were probably first suggested for large scale use in Ceylon in the last war due to shortage of the more conventional anticoagulants. While it seems true that the tendency to severe precoagulation appears at least partially to be a clonal characteristic, the intensity or amount of precoagulation is generally dependent upon the environmental conditions e.g. weather, time between commencement of tapping and delivery to the factory etc. For the latter reasons the details in the literature of definite recommendations or suggestions concerning the quantities of anticoagulants (vide Table 1) to be used should not necessarily be adhered to too rigidly. Insufficient anticoagulant can be almost useless, and an excess can lead to difficulties in the factory such as controlling the size of the first fraction in crepe manufacture.

## TABLE I

*Quantities of the anticoagulant as a % of the weight of latex.*

| Anticoagulant | In cups, Buckets | In Lorry (if necessary) | Method for and comments on the anticoagulant. |
|---|---|---|---|
| Ammonia | .01 % (a) (c) | — | 1. Bubble 1 lb. of ammonia gas carefully and slowly through 10 galls. of water, add 6½ fluid oz. of this solution to 4 galls. of latex (a)(c). 2. Excess or the use of stale latex can affect the crepe colour (e)(c). 3. Recommended for R.S.S. or 'bad cases' (c)(d). 4. Excess can affect drying (c)(d). |
| Sodium Sulphite | .05% (a) (b) | .05% (c) | 1. Make fresh daily by dissolving 1 lb. in 3 galls. of water, use ½ pint to every 4 galls. of latex (a) (c). 2. May not be effective if precoagulation is marked (c). 3. Excess may retard drying and can leave the surface tacky (or glossy), due to moisture absorption not oxidation (e)(c). |
| Formaldehyde | .02% (c) | — | 1. Dissolve 4-5 fluid oz of commercial formalin in 1 gall. of water, use 3 fluid oz per 1 gallon of latex (c) 2. Readily turns acid and has to be neutralised with alkali before use. Make neutral to litmus (c) (e). 3. V. old formalin is not invariably suitable, even if apparently neutral (e). 4. Not so effective, in wet weather or with certain clones, as ammonia and may need care with crepe if adverse colour effects are to be avoided (c). |
| Formaldehyde + Sodium Carbonate (or Soda Ash) (c) | .02% + .02% | | 1. Formaldehyde made up as above. Soda Ash made by dissolving 1 lb. in 10 galls. of water and using 3 fluid oz of this solution to every gall. of latex. 2. For many 'difficult cases' this mixture is an improvement on formaldehyde alone (c)(e)(f). |
| Washing Soda | .10%(e) | | 1. Dissolve in 1 lb. in 3 galls. of water, use 1 pint of this solution per 4 gallons of latex (e). 2. Probably preferred by smallholders on the grounds of cheapness, but there is said to be a risk of bubble formation (b). Can probably be used with care for crepe (e). |

Sources of Data:
(a) R.R.I.C. 2nd Supplement to Adv. Circular No. 17, 1949 Ed.
(b) War Time addenda to early Ed. of (a)
(c) R.R.I.M. Pl. Bull. New Series (May 1953) No. 6 p. 61.
(d) R.R.I.M. C/AL 15 (52)
(e) Other R.R.I.C. sources (f) Other R.R.I.M. Sources.

Conversion Table for use with Table I taken from:

(a) Handbook of Physics and Chemistry 21st Edn. p. 1732-1747. (b) R.R.I.M. Card 7C (1934)

| | | | | |
|---|---|---|---|---|
| 60 minims | = | 1 fl drachm (British) | = 3.55 c.c. | 1 table spoon = ½ fl .oz. |
| 8 fl. drachm | = | 1 fl ounce. (British) | =28.41 cc. | 1 dessert spoon = ¼ fl oz. |
| 20 fl. ounces | = | 1 pint | =568.3 cc. | 1 tea spoon = 1/8 fl. oz. |
| 4 Gills (Br.) | = | 1 pint | | |
| 20 grains | = | 1 scruple | =1.2969 grams. | |
| 7000 grains | = | 1 pound (avoirdupois) | =453.6 grams. | |

Where the tendency to precoagulation is pronounced, successful use of a suitable anticoagulant normally requires the addition of a considerable proportion (often 2/3) of the anticoagulant solution to the cup (or sometimes on the cut) at the commencement of tapping the individual trees. For this purpose the tappers must obviously be trained to portion out the anticoagulant solution correctly between the trees, so that no group of trees is omitted. The balance of the anticoagulant solution (originally issued to the tappers in suitably corked bottles), is added to the buckets usually after collection of the latex from about 15 to 20 trees. Extra anticoagulant may have to be added at the collection centre if the distance between the collection centre and the factory is large.

To summarise, whilst uncontrolled or inadequately controlled precoagulation can cause a crepe or R.S.S. Estate considerable financial loss a tendency to precoagulation need not necessarily render a clone unsuitable for large scale planting. Where crepe is the main product anticoagulants such as sodium sulphite or washing soda powder can often be used with marked success. Where R.S.S. is the main product and the distances between the task and the factory are large, a tendency to bubbles in the finished sheets might be found. The latter is not a portion of the subject which the R.R.I.C. has been in a position to investigate recently, but the presence of small pin-head bubbles in R.S.S. IX and R.S.S. 1 is not objected to in the R.M.A. Inc. 1952 Type Descriptions and Packing Specifications for Natural Rubber (Ann. Rept. Rubber Technol. 1952 16 8). Lastly, it should be noted that whereas this subsection briefly discusses the subject of the prevention of natural coagulation of latex primarily from the viewpoint of crepe and R.S.S. manufacture, the succeeding subsection discusses it from the viewpoint of the manufacture of the latex concentrate.

2. (d) Clones for Latex Concentrate Manufacture: (A Contribution by H.M. Collier on behalf of the Latex Corporation of Ceylon Ltd.)

In selecting clones for the manufacture of latex concentrate the over-riding consideration is that they should produce steadily and economically a high yield of latex that is they should produce a high yield without being unduly susceptible to disease and the general tree characteristics from the planter's point of view should be satisfactory.

Within this framework, however, the concentrate manufacturer has a particular preference for what may be termed in a general way, a stable latex.

The stability of latex is the stability towards coagulation of the individual rubber particles of which the latex is composed. The largest of these particles is no more than a ten thousandth of an inch in diameter, and their stability depends not on the rubber, but on the non-rubber constituents of the latex, some of which cover the individual rubber particles, while others are present in the serum.

Latex stability is a complex function, which may be considered from a variety of different standpoints. For our purposes, however, we may divide it roughly into two parts.

(a) The first, an inherent characteristic of the particular clone from which the latex is derived.

(b) The second dependent on the degree of preservation of the latex, particularly during the first few hours after tapping.

The inherent differences in the latex from different clones arise from differences in the composition of the non-rubber constituents, which, as already mentioned, control the stability of the latex. Of particular importance in this connection are certain trace elements, which, occurring only to the extent of a few hundredths of one percent, may yet have a very marked effect on the properties of the latex.

These inherent differences are well shown by the marked tendency of latex from some clones to precoagulate in the tapping cup before collection. These latices are ones that emerge from the tapping cut at a lower level of stability, for all latices will coagulate spontaneously if allowed to stand unpreserved for long enough. If latex is to be concentrated, it is of course important to collect as high a proportion of the latex as possible in liquid form, and the addition of a few drops of ammonia solution to the tapping cup at the time of tapping will largely offset a tendency to precoagulation. Ammonia is the standard latex preservative, and further quantities must be added to all the latex directly it reaches the collecting station so that it will remain adequately preserved during transport to the latex concentrating factory. It is inadequate preservation at this stage that can cause a marked reduction in the stability of the final concentrates.

At this point it may perhaps be useful to describe briefly a few of the tests used to measure different aspects of the stability of latex. If latex has been inadequately preserved, particularly during the first few hours after tapping, some of the non-rubber constituents of the latex (and particularly the proteins) will break down to an excessive degree. The KOH Number test (Madge; Trans. Inst. Rubber Ind. 28 207 1952) allows the extent of this breakdown to be measured.

This test may be carried out either on the field latex, or on the concentrate; other stability tests are normally carried out on the concentrate. One of the best known is the mechanical stability test (Madge, Collier and Duckworth; Trans. Inst. Rubber Ind. 28 15 1952) which supercedes the hand rubbing test used on the Plantations to gauge roughly the stability of a latex, In this hand rubbing test a spot of latex from the tapping cup or elsewhere, is taken on the finger and rubbed on the palm of the hand. The mechanical stability test is based on the same principles, but the rubbing, or to be more precise, stirring conditions are very carefully controlled to ensure closely reproducible results. The finger is replaced by a disc rotating at exactly 14,000 revolutions per minute, one half inch from the base of the beaker in which the latex is contained. The actual weight of latex in the beaker, previously adjusted to a standard solids content, and temperature, is about three ounces. The test consists in measuring the time which the stirring action takes to produce the first signs of coagulation, the actual end-point being reached when flocs, or small pieces of coagulum first appear on the surface of the latex.

Any test that will give some direct indication of the behaviour of the latex in the manufacturing process in which it is finally to be used is useful. Some of these processes are gelling processes and employ a delayed action gelling agent, which allows a sufficient interval between the addition of the gelling agent and the setting of the latex for the latex to be poured into a mould. Foam rubber manufacture is one such process and the gelling agent used there is sodium silicofluoride. A useful test then is the gelling pH test, in which the action of sodium silicofluoride on latex is observed.

Reference has already been made to the importance of trace elements in affecting the stability of latex. Small percentages of the element, magnesium,

have been found to interfere in the gelling pH test by causing premature gelling, and before the latex concentrate can be entirely satisfactory, this extra magnesium has to be removed. This can be done during concentration, but obviously the manufacturer of latex concentrate would prefer if no excess magnesium were present in the first place. Here perhaps lies the real difficulty in recommending clones that will provide latex particularly suitable for the manufacture of concentrate. In Ceylon, high yield is often, though not perhaps necessarily, accompanied by a high magnesium content in the final concentrate, and the only trees that can at present be relied upon not to give latex containing excess magnesium are seedling trees.

A high magnesium figure for latex from a specific clone was first noted in Malaya for the clone Glenshiel 1 (Madge, Collier and Peel, Trans. Inst. Rubber Ind. 26 305 1950), (also known in Ceylon as M 11). In Ceylon, a clone appears to produce latex with a considerably higher magnesium percentage than the same clone in Malaya, but in Ceylon magnesium figures are at present available for only a few individual clones. In fact such figures are known for only two of the clones included by the Rubber Rehabilitation Board in their recent list of clones qualifying for the replanting subsidy (Ceylon Daily News—4/7/53). These two are P.B.86 and Glenshiel 1, and magnesium figures on concentrate latex from these two clones are very high, being in both cases five or six times the minimum quantity that will interfere in the gelling pH test.

The marked differences in magnesium content of latex from the same clone grown in Malaya and Ceylon has already been remarked. It might appear an oversimplification to speak of the magnesium content in one particular country, since this, like other properties of the clone, such as latex yield, will vary from Estate to Estate. Local variations in the nature of the soil will probably affect the magnesium content of the latex, and such variation will include not only natural soil differences but differences in manuring procedures. Nevertheless these local variations in magnesium content are by no means as great as the overall differences between Malaya and Ceylon, differences which must presumably be brought about by fundamental differences in soil and climate between the two countries.

To sum up, we can say that in selecting clones suitable for latex concentrate manufacture, the same general principles apply as in selecting clones for other types of rubber manufacture. The particular requirement of the latex concentrate manufacturer for a stable latex, principally one of low magensium content is difficult to comply with for two reasons:—

(1) High magnesium content very frequently accompanies high yield, and high yield must remain the overriding consideration.

(2) Insufficient evidence is so far available on the magnesium content of latex from individual Ceylon clones for a list of clones capable of providing latex concentrate with a low magnesium content to be compiled.

The latex producer can, however, greatly aid the latex concentrate manufacturer by ensuring that the latex is adequately preserved as soon after tapping as possible, by attending to general conditions of cleanliness in his collecting and storage operations and by maintenance of clear and accurate records of the type and quantity of clonal plantings.

If this is done the concentrate manufacturer will be able to produce from his plant latex concentrate of good quality.

## Section 3. Increased Factory Output.

3. (a) Introduction:—For the producer the prime object of replanting is an increase in profit per unit area of available land over a long term period by means of a substantial increase in average yield with a minimum additional expenditure in the form of disease control, extra capital outlay and labour costs in the factory etc. From the manufacture viewpoint the principal long term effect of replanting can be a substantial increase in the load on the factories concerned, whether these are the more highly mechanised Estate factories, the smaller Estate hand-operated R.S.S. unit or the Small-Holders cheaply constructed smoke-house. It is scarcely practicable for the writer to predict at all accurately the actual % increase in load likely to be expected; however, the E.W. Whitelaw—S. F. H. Perera 1947 Ceylon Rubber Commission classed uneconomic rubber as (a) for Estates employing hired labour—400 lbs./acre or less and (b) for Small-Holders—250 lbs./acre or less (Commissioners' Report in Sessional Paper XVIII 1947 p.8), and while it is not suggested that these figures may be correct for 1953 it seems improbable that Estates or Small-Holders would be very satisfied with planting material which does not offer a reasonable prospect of at least doubling or trebling the yield figure which would now be classed as the true upper limit of uneconomic rubber. On this very tentative basis one may anticipate in due course, (at least in some cases), a two or three fold or perhaps greater increase in total factory load. In this section some consideration will be given to the subject of the methods to be used for processing the extra crop anticipated.

Where the main product of the factory is crepes and the machinery is not operated beyond one shift, the problem can perhaps be partially solved by an increase in the number of shifts. The R.R.I.C. has no recent direct experience to show that the manufacture of crepes on a multi-shift basis is easy or practicable, although it seems difficult to anticipate any overwhelming objections likely to make this impossible and the Whitelaw—Perera Commission (p 115) recommended that Estates equipped with sole crepe machinery should increase output by night-shift work. Additional drying space or alterations to the present drying arrangements would almost certainly be necessary in some cases. If the factory equipment is wasteful of labour or incapable of making best quality material, multi-shift operation of existing units might not turn out to be the most economic system on a long term basis and in this connection it is worth noting that the Whitelaw-Perera 1947 Commission stated (p 109) 'we doubt if there are more than a dozen factories in Ceylon making really first class sole crepe'.

Where the main product of the factory or small-holding is R.S.S., multi-shift operation may be more difficult. Here also the R.R.I.C. has no recent direct experience, but difficulties due to hardening of the coagulum used for mechanically operated R.S.S. mills can be anticipated unless delayed coagulation becomes the practicable solution. Briefly where the factory is already working at or near full normal standard capacity the additional crop anticipated from replanting may perhaps be processed by suitable factory alterations, by sale to organisations engaged in latex concentration or by sale to specially enlarged fully mechanised and modernised factories e.g. centralised factories.

It is not improbable that one of the last two alternatives may not be the preferred solution to this problem and already there are signposts pointing in this direction e.g. the establishment of a Latex Corporation of Ceylon's unit near Kalutara and, the sale of latex or coagulum by certain medium sized

Estates to larger, almost adjacent, ones and perhaps the gradual establishment of a system of Small-Holders Co-operatives may even be included in this heading.

The views of the consumer on the subject of centralised factories are of considerable interest and para 10 of a document signed by the Chairman, Technical Sub-Committee, London Advisory Committee for Rubber Research (Ceylon & Malaya) and by the Chairman, Technical Sub-Committee, Federation of British Rubber Manufacturers' Association reads as follows:—

"The Sub-Committee consider that centralisation of preparation on as large a scale as possible would solve many of the difficulties associated with the preparation of technically uniform rubber and would offer more scope for mechanisation and for the introduction of new methods which would also lead to better packing, ease in handling, shipping and storing. One of the advantages of the Synthetic Rubber Industry is that it consists of a few, very large producing units which can quickly give effect on a commercial scale to new developments and improvements in quality.

The Sub-Committee appreciates that the centralisation of natural rubber preparation involves formidable problems, but hope that priority can be given to a study of the technology of the large scale manipulation of latex and rubber which must precede any attempt to solve the commercial and political difficulties involved".

The Whitelaw-Perera 1947 Rubber Commission recommended (pp. 113-115) the establishment of centralised factories capable of making all the modern types of rubber e.g. crepe, R.S.S. etc. and suggested 4 areas for siting these factories. In this case the proposal for centralised factories may have been an extension of the ideas behind Small-Holders Co-operatives and would have been designed therefore to ensure that Small-Holders' and small Estates' latex could be made into the most profitable high quality product thereby reducing the % of low grade R.S.S., when this is unprofitable. There seems to be no valid technical reasons why Estates of any size and Small-Holders should not, when desired, contribute latex to centralised factories which could perhaps be built around existing Estate factories once all the problems involved have been solved. For this reason inter alia representatives of Messrs Brown & Co. Ltd. have been asked, with the approval of Messrs Carson Cumberbatch & Co. Ltd., to describe in subsection 3(b) the layout adopted at Nakiadeniya factory which might be regarded as a centralised crepe factory. For similar reasons subsection 3(c) contains a description of some of the R.S.S. equipment at present available or which could be made in Ceylon.

As Planters in Ceylon may not all be familiar with the basic principles involved in the conversion of 'bought' latex to latex concentrate by centrifugal processes, The Latex Corporation of Ceylon Ltd. have kindly submitted a brief description which is reproduced in subsection 3(d). For information on the form in which the latex is bought etc. Planters are referred in the first instance to Messrs The Latex Corporation of Ceylon Ltd., P.O. Box 1044, Colombo.

3 (b) Nakiadeniya Blanket Crepe Factory Layout. (A contribution by K. Wickham, Director and Chief Engineer, Messrs Brown & Co. Ltd., P.O. Box 200, Colombo.)

Every Superintendent has at some time or other probably realised the benefits that would accrue, were it possible to break away from the old conventional style of Rubber Factory with its somewhat cumbersome form of prime

mover, line shafting, and inevitable conglomeration of belts & pulleys, and adopt a system of manufacture rather more on the lines of the American Endless Belt system.

Unfortunately, it is seldom possible to arrange a Rubber Factory with this object in view, since it is usually a question of adding additional machinery to an existing factory and making the best possible compromise to fit in with the existing arrangements.

Recently, however, we were fortunate in being able to co-operate with Messrs. Carson Cumberbatch & Co. Ltd., in designing an entirely new large scale Blanket Crepe Factory for Nakiadeniya Group. The result is the combined efforts of the Resident Superintendents, the Visiting Agent, Messrs. Carson Cumberbatch & Co. Ltd. and the Engineers of Messrs. Brown & Co. Ltd.

Nakiadeniya Group has at present a crop of approximately three million pounds annually, estimated to increase to five million pounds in 1964. The requirement was for a factory to handle this crop at the lowest cost of manufacture.

The latex is collected by Ferguson Tractor with 400 gallon trailer tankers and discharged directly into bulking tanks, advantage being taken of the contour of the land for a raised roadway to assist gravitation.

Distribution from the bulking tanks to six coagulating tanks is by large tiled troughs so arranged that selectivity can be obtained and the coagulating tanks are fitted with duro-aluminium separators obviating the necessity for coagulum cutters. A shallow tiled trough sloping from either end to a central position runs across the ends of the coagulating tanks into which the coagulum slabs are delivered and assisted to a position opposite the first macerating mill by a continuous water spray, thus achieving a flow-through system and obviating excessive handling.

The battery of mills in the wet rolling section consists of two 26″ fluted mills and one 26″ diamond grooved intermediate mill; these three mills being placed one in front of the other and delivering to six 26″ smooth mills, forming a double arc and so positioned that each mill will clear itself without interference to the operation of the adjacent mill. An additional two smooth mills will be installed when the crop increases plus a further 26″ diamond mill.

The finished laces are wound on to spools and transported by aluminium trolleys to an electrically operated hoist for distribution to any of the four floors of the large capacity Drying Tower situated approximately in the centre of the factory. The dry laces are discharged by chute to the Dry Blanketing Section where two 26″ Blanketing Mills complete the final rolling.

Sorting, Packing, and Weighing is then done in this Section and delivery completed to lorries in a covered Loading Bay.

To achieve a continuous flow-through method of manufacture, it was decided that electrification was essential and alternating current was decided upon for economic reasons. Power is provided by a 255 H.P. Ruston oil engine and a 172 K. W. Lancashire Dynamo & Crypto Alternator.

Due to the relatively low speed of the mills, these are driven by independent geared Lancashire Dynamo & Crypto Motors.

All wiring is beneath floor level in Pyrotenax material insulated cables. Fluorescent lighting is installed throughout the ground floor to ensure shadowless conditions and standard Tungsten Lamps in the Drying House.

The drawings submitted with this paper should clearly illustrate what is believed to be the first factory specifically designed to produce first grade Crepe on a large scale by a flow-through method with minimum manufacturing costs.

3. (c) R.S.S. Production: The present Colombo price for R.S.S. (in comparison with crepe prices) has not unnaturally encouraged more and more producers to consider the manufacture of part or all of their crop as R.S.S. While this trend may not be expected to continue indefinitely, certain Estates or centralised factories may consider it desirable to be able to turn a portion of the extra crop anticipated from replanting into R.S.S. The object, therefore of this section is to draw the attention of those Proprietors and Planters, who are unfamiliar with R.S.S. production, to the facilities and information available in Ceylon on certain aspects of R.S.S. production. Details on procedures for small holdings are normally available through the Small-Holdings Dept. of the R.R.I.C. (e.g. The Small-Holdings Propaganda Officer, Small-Holdings Department, R.R.I.C., P.O. Box 901, Colombo), and information of value to small and some large Estates is to be found in "The Perparation of Plantation Rubber."

Typical modern R.S.S. factory layouts can no doubt be furnished by any of the Estates' equipment engineering companies in Colombo and it is hoped to project typical Sheeting Factory layouts with fixed tanks and with tanks on trucks (Colombo Commercial Co. Ltd.s' Drawing No. 672—D, 673—D.) at the time of the conference. Various types of sheeting batteries are available on the market and the size and type of battery suitable may depend on the output required. For high speed operation and large output, 5 or 6 roll batteries have been suggested (Preparation of Plantation Rubber p.12) however 2 compact 4 roll batteries are available locally being made by Messrs Brown & Co. Ltd. and by Messrs Hoares (Ceylon) Ltd. Various comments made on the equipment are given in an appendix at the end of this subsection. The R.R.I.C. has no experience of Messers Hoares' multiple rollers and has only recently installed a Brown's Guthrie Cadet which is available for inspection at Dartonfield. However a Guthrie Cadet was previously available for a short time at the R.R.I.C. and abstracts from a report prepared by T. E. H. O'Brien in 1940 are also given in the appendix.

The major portion of the smoke-houses constructed in Ceylon seem to be of single storey Small-Holders type or of the multi-storey R.R.S. type. While the latter has certain undoubted advantages, including the fact that the main building framework is suitable for conversion to crepe drying, it is not the only nor necessarily the most suitable design. For this reason it is proposed to discuss certain of the basic principles involved in smoking and drying R.S.S. and to give a short description of the R.R.I.M. tunnel type smoke-house. The principles involved in the drying of plantation sheet rubber as normally carried out have been considered in some detail by various writers (J. H. Piddlesden: J. R.R.I.M. 1936/7 7 117; J. Clouaire Rev. Gen. Caoutchouc 1953 30 34; *et al*). At the start of the drying operation the moisture will be expected to be uniformly distributed throughout the thickness of the sheet. As drying proceeds the moisture at the surface evaporates and the moisture in the internal layers of the sheet slowly diffuses to the surface. At the completion of drying the remaining moisture is uniformly distributed throughout the thickness of the sheet

and the moisture content attains an equilibrium value depending upon the material and it's environment. Basically therefore, the rate at which water is lost by the sheet will depend upon either Ve, the velocity at which water can leave the surface of the sheet, or Vd, the velocity at which water can diffuse towards the surface.

During the initial stages of drying when the surface remains uniformly wet, the rate of loss of moisture can be constant if certain conditions remain constant. In this constant rate period the drying time depends primarily upon the surrounding air and for high drying rates it is normally necessary to establish the maximum vapour pressure difference between the surface of the sheet and the air in contact with it. In practice this implies removal of the layer of nearly saturated air in contact with the surface, and the establishment of conditions such that the partial pressure of water vapour in the air is as far below saturation as practicable i.e. a low % relative humidity is implied. The surface of the material must not cool unduly with evaporation, or dew will be deposited. When dry patches appear on the surface at the end of the constant rate period, the drying enters the falling rate zone divided by Piddlesden into 2 portions—(a) the zone of unsaturated surface drying, in which the external conditions are still important but are modified by the fact that as drying proceeds the area of effective wet surface diminishes so that the drying rate is often roughly proportional to the moisture content of the solid and (b) the zone of internal diffusion.

In the zone of internal diffusion Ve$>$Vd and diffusion no longer keeps pace with surface evaporation and therefore becomes the factor controlling the drying rate. Under these conditions the drying time is said to depend primarily upon the temperature and nature of the sheet and is proportional to the square of the sheet thickness (van Harpen's law), rather than to the sheet thickness which is to be expected in the earlier stages. This implies that for rapid drying over the internal diffusion zone the sheets should be as thin as possible, the temperature as high as the material will permit and that a slight reduction in the amount of air leaving the unit (in comparison with the constant rate period) might be economically desirable to conserve heat and reduce costs.

In the standard types of sheet drying units, e.g. units where the humidity control is not independent of the temperature and the number of air changes/hour, and where the heat required for evaporation is obtained principally by convection, the constant rate period of drying is much smaller than that where diffusion is the rate controlling factor. Hence the period over which the temperature might with advantage be high covers the major portion of the total drying time. With the multi-storey R.R.S. type smoke-houses in continuous use, temperatures in the region of 140° F are not generally practicable due to the risk of blister formation. Operation at a lower temperature and the necessity of removing the heating source for a certain period each day to change the sheets substantially increases the drying time of conventionally operated R.R.S. smoke-houses (compared to some alternative smoke-houses).

In the Subur type smoke-house (A. Moore, J. H. Piddlesden: J. R.R.I.M. 1936/7 7 147), distinct chambers are available in which the temperature and amount of air are carefully controlled according to the state of dryness of the sheets. Thus, the first chamber might operate at about 100° F for 3 hours then at about 110-115° F and the last chamber at about 140-145° F. In the R.R.I.M. tunnel type smoke-house (J. H. Piddlesden; J. R.R.I.M. 1937/8 8 258 *et seq;* R.R.I.M. Planting Manual No. 9) the major objections to the Subur type are overcome and individual chambers with turntables between them are

no longer necessary. The smoke-house is a tunnel shaped building with a light rail track running down the centre along which the trolleys containing the sheets proceed. In general 1 trolley is used for each day's crop, and as a fresh trolley of dripped sheets is inserted at one end a trolley of dry sheets will be withdrawn at the other end and the smoke-house closed down again. The smoke-house is heated by an outside furnace and the hot air and smoke from the furnace pass through a trench type flue which runs along the length of the building, between the rails, with outlets, under the centre of each truck or as required. Adjustable smoke outlets are provided in the ceiling above each trolley and by adjustment of the ventilators it is possible to maintain a temperature gradation in the building e.g. say 115° F in the wet rubber end and rising upto 140° F in the dry end. Provision is made to drain the water, dripped from the sheets, to the outside of the building. The furnace originally used with the tunnel type smoke-house is of the thin wall type enclosed in an outer case, the heat radiated from the furnace arch being collected by a stream of air which passes between the furnace arch and the outer case and thence into the smoke-house.

In Malaya an efficient smoke-house of this type will probably use about a ½ pound of firewood per pound of rubber dried.

An experimental tunnel type smoke-house is under construction at the R.R.I.C. and may be available for examination at the time of the conference. It is hoped to reproduce various slides illustrating the construction of these buildings at the conference.

**Appendix No. 1.** The Guthrie Cadet R.S.S. Mill. (A contribution by K. J. Wilkin of Messrs. Brown & Co. Ltd. P.O. Box 200, Colombo).

For those Estates whose crop figures are 1,000 lbs. and upwards per day, consideration must be given to more rapid and economic methods of manufacture. To this end automatic multiple roll sheeting batteries were developed, of which the Guthrie Patented 4-Roll Automatic Battery is an example. First exploited in Malaya, it proved an immediate success and has been adopted for use in Ceylon. Approximately 55 machines being installed and in use up to the present time.

The Guthrie Cadet will machine with equal efficiency and economy slab and continuous coagulum, although the latter process has not been adopted in Ceylon to date as far as can be ascertained.

Output figures will vary accordingly with the layout of the factory but under ideal conditions should be approximately as follows:—

| | | |
|---|---|---|
| Continuous coagulum method | ... | 1,000/1,200 lbs. per hour. |
| Slab coagulum, tank edge type coagulum method | ... | 700/750 lbs. per hour. |
| Slab coagulum, dish method | ... | 600/650 lbs. per hour. |

The "Cadet" as is now well known consists of 4 pairs of rollers; 2 pairs flat faced, 1 pair smooth and 1 pair marking rolls, all mounted on a common C.I. frame. The rolls being driven through Renolds chain drive and chain sprockets arranged to regulate correctly the speed of the individual rolls. All chains and sprockets working in a totally enclosed oil bath.

Patented "Reginato" chutes are fitted. These are constructed of aluminium and monel metal, and are supported by pivots and springs between

the pairs of rollers of the Batteries. They are shaped in a particular way and have a number of metal discs turning freely under the friction of the travelling coagulum; the combined effect is to keep the coagulum in the centre of the chutes and prevent side jamming.

Again if the coagulum begins to pile up at the second or third pair of rollers, the chute rises and takes up the slack and this action together with its shape and some minor devices is sufficient to release the pressure from behind until free running is resumed.

Should the coagulum become too greatly tensioned, because the rate of movement between two pairs of rollers does not synchronise for some reason, the chute sinks down and releases the tension. This allows the rotation of the rollers to re-synchronise without danger of tearing the sheet and, when the feed is again normal, the chute rises to its usual position.

There is thus a flexible and rapidly acting compensatory motion and this, with the shape of the chutes and arrangements of discs, is the feature causing the automatic travel of the coagulum.

A 5 BHP prime mover is sufficient to drive both the Cadet Battery and a small water pump. The power to the Mill being transmitted through a flat belt to fast and loose pulleys fitted to the Mill or by alternative means if so desired.

This machine can be supplied completely erected and installed for the sum of Rs. 7,832/00, subject to the usual Estate commitments.

**Appendix No. 2.** Abstract from a Report on a Guthrie Cadet Mill by T. E. H. O'Brien in 1940.

In the course of a series of trials it has been found that the machine can be adjusted to give satisfactory results when rolling coagulum $1\frac{1}{2}$ inches thick, prepared from latex diluted to a dry rubber content of $1\frac{1}{2}$ lbs. per gallon and milled 18 - 20 hours after coagulation. Under these conditions, however, the machine is sensitive to variations in the thickness and consistency of the coagulum and stoppages are liable to occur if the slabs of coagulum are slightly thicker or harder than usual. A machine comprising only four rollers is working to the limit of its capacity when rolling $1\frac{1}{2}$ inch coagulum into sheets sufficiently thin for efficient drying, and it has been shown that all difficulties in this direction can be avoided if the thickness of the coagulum is reduced to $1\frac{1}{4}$ inches or if the latex is diluted to a dry rubber content of $1\frac{1}{4}$ lbs. per gallon before coagulation. It has further been shown that the use of thinner or softer coagulum does not lead to a reduction in the output of the machine as might be expected. This is probably due to the fact that more slip occurs when hard thick coagulum is rolled.

The calculated figures for output per hour (784 to 893 lbs. depending on the conditions) make no allowance for the time required for moving coagulating tanks into position near to the machine, removal of partitions etc. Unless additional labourers are employed an allowance of about 12 minutes per hour must be made for this work and the effective output will be reduced to 650 - 750 lbs. per hour, according to the type of coagulum. It is believed, however, that the operating speed of the machine could be substantially increased without impairing its efficiency.

The battery can be recommended as a suitable unit for handling crops up to about 3,000 lbs. per day.

**Appendix No 3.** HOARES MULTIPLE RUBBER ROLLER, (A Contribution by Major J. H. Hoare of Hoares (Ceylon) Ltd., P. O. Box 22, Colombo).

Messrs. Hoares (Ceylon) Ltd., Colombo Engineering Works, offer an improved, patent four-roller sheeting unit, which is available for direct drive from an independent engine or electric motor or from line shafting. Alternatively a hand drive can be supplied for use in the event of power not being available, at a small extra charge.

This machine uses a 5 H.P. engine, and an approximate output of rubber (wet) of 800 to 900 pounds per hour is claimed by the makers.

The original version of this machine was installed in a number of Ceylon rubber Estates in the early 1920's and many of these machines are still giving reliable service, which is a tribute to their sturdy design.

Since then the machine has been consistently kept up to date within the scope it accords for development. The design is specially simple and the parts are easily replaceable in the event of wear or a breakdown. The designers have kept in mind the rough handling which such units can receive from rubber factory labour.

The machine consists of a sturdy frame comprising two gable members accurately located on a cast iron bed-plate. The frames are adequately braced transversely, so as to be perfectly rigid. There are four pairs of rollers, independently adjustable, and driven at a predetermined speed by means of continuous gear trains. The speeds are set by the design so as to ensure the correct movement of the pressed coagulum as it is transformed into sheet. The first pair of rollers is knurled and through it the coagulum is fed. A safety guard prevents the operator from catching his fingers in these rolls, and should he tamper with the guard, it will release a catch and automatically throw the belt on to the loose pulley, thus stopping the machine. This arrangement meets with the approval of Factory Regulations.

After passing the first pair of rolls the coagulum is pressed further in two successive pairs and finally leaves the lower pair of grooved rolls, which rib the sheet.

All bearings are grease lubricated from easily accessible grease points. The gears are double enclosed by covers. Aluminium feeding and discharge trays are fitted, together with suitable intermediate trays of the same material. If necessary, a supply of water can be fed to the upper rolls.

It is not proposed to go into the various recommendations for preparation of coagulum, which, for the purposes of this machine, should be the normal recommended procedure. However, users are warned against exposing the coagulum to the sun or admixture of bleaching agents, which tend to cause stickiness on the first pair of rolls. The setting of the rolls is important. A set of brass feeler gauges are supplied with the machine for this purpose, which give the distance between the knurled rolls as ¼″ approximately, first smooth rolls 5/32″, second smooth rolls 1/16″ and finally, the grooved rolls are closed together. The coagulated sheet is pressed and fed to the knurled rolls at the feeding end and withdrawn from the discharge end, being finished in one operation, ready for the smoke room. There is thus, a great saving in labour, as

one labourer to feed and another to collect the sheet at discharge comprises the team for successful operation of the machine.

Adequate grease lubrication should be maintained through the grease cups, which are all easily accessible. A little grease should be applied to the teeth of the gear wheels about once a month. The old grease should be cleaned off before applying new. The machine should give several years' service before it is necessary to rebush the phosphor bronze journals. Usually at this time it may be necessary to attend to the fit of the adjusting screws, which should always be free from play or looseness.

Unfortunately, the company has not been able to install one of these machines for observation by the R.R.I.C., as it is a little more expensive than another machine which does similar work, and funds would not allow purchase of every type of machine available.

Considerable numbers of this machine are in use in Ceylon, South India, Malaya and further afield in Indonesia and Australasia.

For further detailed information on this roll Colombo manufacturers should be approached. The ex Works, Colombo price of the standard Multiple Rubber Roller is Rs. 9,100/-, hand operated gear extra Rs. 453.75. These prices are subject to a 5% agency discount.

3. (d) Latex concentration. (A contribution by H. M. Collier on behalf of Messrs. The Latex Corporation of Ceylon Ltd.).

Directly the latex collecting tanker arrives from the supplying Estate at the factory where concentration is to take place, it is weighed and a representative sample taken for dry rubber and ammonia content determinations. After the latex has been discharged into a reception tank the total weight of latex supplied by the Estate is found by re-weighing the tanker. The total weight of rubber in the latex may then be calculated by reference to the dry rubber content of the sample already taken. The dry rubber content is determined by weighing out a small sample of latex, coagulating the rubber with 2% acetic acid, and then sheeting, washing and drying the coagulum that results. This method of determination has recently been discussed at some length by Risdon (Quarterly Circulars of the R.R.I.C. 28-1, 3 and 7 1952). A determination of the ammonia content of each sample is also made to ensure that the correct quantity of ammonia for adequate preservation of the latex during transport has been added at the supplying Estates. Directly the full day's crop has been received from all the supplying Estates the latex in the reception tank is thoroughly mixed prior to centrifuging.

The object of centrifuging latex is to increase the concentration of the rubber particles by removing as much as possible of the watery serum in which they are suspended. Latex at the higher cencentration which results is required for most manufacturing processes, but even if it has to be diluted again before use, the removal of the serum considerably reduces transport costs. The centrifuging process for the removal of some of the serum depends on the difference in density between the rubber particles and the serum. This difference in density is not, however, sufficiently great, especially as the rubber particles are extremely small, to allow any separation to take place under the force of gravity alone as it does for instance in the case of air bubbles suspended in water. The centrifuge replaces gravitational force by a centrifugal force many thousand times greater. This is done by rotating at 8000 revolutions a minute the centrifuge bowl through which the latex is continuously led. The

centrifuge bowl contains a number of plates or discs which facilitate the separation of the more concentrated latex, and the final results is that the concentrate and skim emerge from the centrifuge in two separate streams (Zacchariassen; Planter 27, 483, November 1951.)

The dry rubber content of the field latex can vary considerably with its source, though on the average it is usually between 25% and 35%. In addition to the rubber the field latex contains perhaps 3% of non-rubber constituents, which stabilise the individual rubber particles.

The dry rubber content of the concentrate has been increased to about 60% while the non-rubber constituents have been reduced during centrifuging to about 1.5% of the latex. It will be seen, therefore, that centrifuging not only increases the concentration of rubber in the latex but also purifies it to a certain extent by removing some of the non-rubber solids.

Directly the latex emerges from the centrifuge it passes to a large drum where gaseous ammonia is added since it is necessary to increase the ammonia content before it is consumed in some manufacturing process. In actual practice, of course, several centrifuges are run simultaneously, fed from the same reception tank. After several hours running the centrifuge bowls will tend to clog up and a carefully planned operating schedule must be worked out to ensure the minimum loss of time for stopping and cleaning. After ammoniation the latex is bulked in a large stirred storage tank to await transport to the dock tanks at Colombo, and subsequent transhipment to Great Britain in large ships' tanks.

If centrifuging were 100% efficient the serum which is separated from the latex concentrate would contain no rubber. This is not the case, and centrifuging takes place at an operating efficiency of about 85% with the result that a small percentage of rubber remains in the skim. The actual concentration of rubber in the skim can vary widely, but is usually about 5%.

Because large particles concentrate more readily in the centrifuge than small, the skim rubber contains a particularly high proportion of small particles. Such particles are more difficult to coagulate, and for this reason the ammonia content of the skim has to be reduced and the particles destabilised to a certain extent before the skim can be satisfactorily coagulated with acid. The skim sheet that is finally prepared forms a useful by-product of latex concentration.

**Section 4 Factory Services.**

4. (a) Introduction. Increase in factory loads or the construction of centralised factories is likely to raise certain problems in the matter of factory services. For example, the supply of suitable quality water in sufficient volume and the disposal of the raw rubber factory effluents without creating a public nuisance. Certain aspects of the latter problem are treated in this section.

(b) Effluent Disposal. Waste waters from rubber factories contain varying amounts of serum substances which are not stable indefinitely, particularly in the presence of certain microorganisms. Such substances must be regarded until proved otherwise, as distinct water pollution risks and as such it is questionable whether their discharge into medium or small sized streams and rivers will be permitted indefinitely. Where the effluents pass within the boundaries controlled by public spirited authorities, complaints are likely to be received at least in some cases, at certain times of the year.

Discharge of chemicals, naturally occurring or otherwise, into public or private water-ways or streams can be objectionable since conditions partially or wholly toxic to the human, animal or plant life using the stream can be produced in one or all of the following ways: (1) the chemicals added may be toxic per se (2) the decomposition products obtained either by chemical changes or as a result of the action of certain microorganisms may be toxic or (3) the process of decomposition may involve a substantial decrease in the equilibrium oxygen content of the stream. In the latter connection it should be understood that the oxygen content of a stream is a balance of various factors e.g. depletion by fish, worms, insect larvae, etc. and replenishment by absorption from the air and by photosynthetic processes in the plants (i.e. in the daylight). Rapid depletion of the oxygen content of the water during the decomposition of waste products can upset this natural balance and give rise to conditions toxic to animal and plant life.

Destruction of organic matter in water may take place as a result of the action of aerobic or anaerobic microorganisms. Where anaerobic conditions occur the final product of the reaction may include hydrogen sulphide, methane and ammonia, and where aerobic conditions predominate the final products may include nitrates, sulphates, carbon dioxide etc. In general anaerobic decomposition is expected to give rise to most unpleasant smells. However, according to the literature (A.C.S. Monograph No. 74 pp. 602-3), decomposition of latex in the absence of air and oxygen favours the fermentation of the sugars with the production of acids and carbon dioxide. In the contact with air the protein consuming microorganisms become active forming a yellow slime on the surface of latex, and eventually causing the evolution of hydrogen sulphide.

Exactly what happens when serum water is discharged as part of the raw rubber factory effluent is primarily a matter of conjecture at present. Presumably when the serum water is well mixed with large volumes of rain water, milling water and mill cooling water, the drainage ditch kept well flushed and clean, and the stream large, fast flowing and turbulent very little noticeable pollution in the form of bad smells will be observed. Under such conditions the polluting solids may be distributed over a large volume of water so that the microorganisms concerned accomplish partial or complete destruction of the solids without too high a reduction in oxygen content of the water. Alternatively after a sufficient time or a sufficient distance of flow the partially degraded stream tends to regain it's original status. However when the serum water is not well diluted,the drainage ditch stagnant or perhaps dirty, and the stream small, very slow flowing and not very turbulent, pollution in the form of bad smells, dead fish and dying plant life may be observed.

Therefore, where the volume of serum to be disposed of is large, as might be the case with centralised factories or where the supply of water for dilution is strictly limited, disposal of serum water could be a serious problem. At present the R.R.I.C. has in hand a programme designed to ascertain whether serum water can be treated on a small scale basis so that the final effluent shall be substantially odourless under all normal conditions and shall represent, on discharge with only small amounts of dilution water, a relatively minor pollution risk. With latex, protein putrefaction (see above) is believed to be a major source of odour production, but so far attempts to find a simple economic method of removing proteins from serum have not been successful. Simple aeration of undiluted or only slightly diluted serum, stored in R.S.S. pans in light, readily produced unpleasant odours, and it seems questionable whether aerobic treatment of substantially undiluted serum will be practicable unless

the total solids content of the solution is reduced (either by much dilution or) by a prior anaerobic digestion. It is intended that both there processes should be investigated in due course.

A small scale (40 gallon oil drum) anaerobic unit equipped for continuous operation, slow speed (sludge agitation) stirring and a 5 day retention period is now in experimental operation. The operation of this unit was started by innoculation with a large dose of cowdung and the strength of the raw material added, e.g. serum water, gradually built up so that the unit can now be fed with undiluted serum. This treatment seems to reduce the oxygen demand of the serum, as estimated by the permanganate method (5 day B.O.D. figures will be available later) by about 80 to 90%. However this effluent does not appear suitable for discharge without further treatment.

At present the anaerobic stage effluent is allowed to settle and the supernatant fluid oxidised on percolating filters (an aerobic process). The percolating filter in use is a cylindrical unit filled with comparatively uniform metal. Operation of the unit is started by dosing with cowdung and the concentration of the raw material gradually built up in a maturing process which may require about 1 month. At present the R.R.I.C. units are using 1 part of settled anaerobic stage effluent to 2 parts of water. Since the process is an aerobic one intermittent operation is necessary and the present cycle is 4 minutes running followed by a 4 minutes draining period. The final effluent appears to be vast improvement over the original serum from the pollution viewpoint but the experiments are still in progress.

To summarise, uncontrolled discharge of raw rubber factory wastes to public and private water-ways can cause considerable pollution. From the information at present available, it appears that reduction of the pollution risk will be possible using suitably modified trade wastes treatment procedures. The by-product gases probably largely methane, may be suitable as heat sources for drying purposes. For information on the closely related subject of sewage disposal in rural areas Estates are advised to refer to the Ross Institute Industrial Advisory Committee's Bulletin No. 8 of 1952, and for a detailed treatment of the whole subject reference may be made to 'Treatment and Disposal of Industrial Waste Waters' by B. A. Southgate, published 1948 by Her Majesty's Stationery Office U.K.

Acknowledgement is made to the officers of the Water Pollution Research Laboratory, Watford England for assistance and advice on the subject of industrial wastes disposal, and to M. Nadarajah who carries out most of the experimental work on this subject at the R.R.I.C.

**Section 5. Marketing and Quality.**

5. (a) Introduction. Replanting with high yielding disease resistant material could be of little use if the rubber produced and despatched from Ceylon does not meet the expectations of the consumer. While the Trade Pact with China assures a stable price and market for a large part of Ceylon's rubber for some time to come, the quality of the rubber shipped from Ceylon must at least be upto that exported by other producing areas. Every new attempt by producers elsewhere to improve the quality and sales appeal of their product must be carefully investigated and at the correct moment applied in Ceylon. In this section it is proposed to discuss certain aspects of the packing of R.S.S., the presence of foreign matter in rubber and technical classification.

5. (b) PACKING R.S.S.; FOREIGN MATTER IN RUBBER: The Minister of Agriculture and Food in his address to the annual general meeting of the Planters' Association of Ceylon stressed that in concentrating on replanting equal importance must be paid to the improvement in the methods of packing, grading and marketing. At present almost all, if not all, R.S.S. is packed and shipped by specialist Packing Companies in Colombo or Galle in the form of bare back bales. This means that the individual sheets of R.S.S. are packed inside wrappers made by joining together other pieces of R.S.S. Recently the R.R.I. of Malaya in a review (R.R.I.M. Planters' Bulletin New Series 1953 No. 7) listed a number of the requirements which bare back baling should fulfil. Thus the baling should be cheap, with the individual bales rigid, not deformed, protected from contamination and non-massing. Also the wrapper sheets must be easily removable when required, and neither the bale coating nor the marking compounds should present the consumer with any difficulties in processing or disposal.

The exact position regarding complaints, claims and discounts against Ceylon's R.S.S. bales in the respect of the above requirements, prior to the Trade Pact with China, is not entirely clear to the R.R.I.C. There is some evidence to suggest that some Ceylon R.S.S. used to be shipped on top of other cargo and that for this reason distortion of the bales in transit was minimised; but, on the other hand it is unfortunately to be noted that various persons visiting Ceylon in a technical capacity have commented adversely on the external appearance of Ceylon's R.S.S. bales and on the apparent absence of suitable baling equipment in a number of Ceylon's Packing Houses. Distortion and massing of bales in transit and storage can result in increased handling charges, obliteration of marks, increased insurance and inspection charges and can produce a sense of frustration and confusion, which may be heightened by comparison with the well packed brick shaped bales of synthetic rubber.

There seems to be adequate evidence that well pressed Malayan Estate produced R.S.S. bales are in general quite satisfactory from the viewpoint of distortion, and since the sale of R.S.S. is now mainly concentrated in the hands of a limited number of Packing Companies, the latter might be well advised to consider carrying out such experiments and purchasing such equipment as may seem necessary to ensure that the packing of their R.S.S. bales can be upto the standards expected in other producing areas.

The subject of the proportion and type of foreign matter, e.g. dirt and harmful chemicals, permitted in natural rubber is a matter of interest to both Packing Companies and Estates. In connection with the introduction of harmful chemicals it may not be fully appreciated that the R.M.A. Inc's 1952 Type Descriptions contain a clause defining the upper limit of copper and manganese in rubber at 8 and 10 parts per million respectively. Any yield stimulation experiments using copper sulphate have therefore to be carried out with great care to prevent spilling the chemicals on the panels and in the spouts and cups.

The views of U.K. manufacturers on dirt in R.S.S. have been summarised in the abstract below, taken from the document entitled 'Manufacturers General Requirements regarding Quality of Commercial Supplies of Rubber' and signed by the Chairman, Technical Sub. Committee of the London Advisory Committee and by the Chairman, Technical Committee of the Federation of British Rubber Manufacturers' Association:

"The Sub-Committee appreciate that R.M.A. grading is largely based on cleanliness and that there is an implication that any manufacturer can obtain

clean rubber if he is prepared to pay the price. Unfortunately outside wrapping sheets pick up an appreciable amount of dirt in handling and during inland transport and are very difficult and often impossible to separate from the rest of the bale. Consequently even clean R.S.S. I and IX grade rubbers have to be strained before use for some important purposes, an operation which may cost as much as 1d. per lb. In the circumstances the Sub-Committee suggests that the problem of preventing firm adhesion between outside wrapping sheets and the rest of the bale requires careful study, particularly for R.S.S. IX and I grade rubbers.

The Sub-Committee are concerned to learn, however, that some R.S.S. I is not sufficiently clean for important purposes even after the outside wrapping sheets have been removed. The view has been expressed that there is a basic lack of cleanliness of considerable concern to manufacturers and that the position is worse than it was pre-war. In fact some British manufacturers consider that improved cleanliness is of more importance than technical classification."

While this document makes it quite clear that manufacturers are not entirely happy about the cleanliness of even R.S.S. I, there seems at present to be no general agreement concerning the actual proportion and types of foreign matter which should be allowed in the various R.M.A. grades. The matter is complicated by the difficulties involved in the determination of dirt in rubber and by the apparent lack of a clear-cut decision on how much and what type of dirt is permissible in the raw rubber bought for various end-uses. Obviously the ideal of no dirt is unlikely to be attained by small inadequately equipped factories whose rubber is sold loose and passes through several hands before being packed.

To summarise, Packing Companies are advised to use the period of a guaranteed market as a result of the Trade Pact with China to ensure that they are equipped to undertake high quality packing of R.S.S.. Estates are advised against large scale trials with copper sulphate except with special care, and are warned about the views of certain manufacturers on the quantity of dirt to be found in even high quality R.S.S.

5. (c) Technical Classification. Much has been written on this subject in Ceylon and elsewhere and most Estates should be aware of the basic principles underlying this subject. In brief, while the standard R.M.A. grading is of value to consumers it is not a sufficient guide to the technical behaviour in particular to the technical uniformity of consignments of natural rubber. Technically classified natural rubbers are rubbers (not sole crepe) whose normal market classification is supplemented by additional information of a technical character obtained by testing suitable samples of the rubber. This information is made available to the consumer by means of marks on the outside of each bale of the consignment. The present system of classification was suggested at the 1949 meeting of the International Rubber Study Group by the French Delegation and has been investigated in some detail mainly in Malaya, Indo- China and Indonesia.

A substantial volume of technically classified rubber, mainly R.S.S. I, has now been placed on the market, principally by Malaya; the actual tonnage being very approximately 3,500 in 1950, 9,000 in 1951 and 25,000 in 1952. While quantities of this order may not be sufficient to develop an insistent demand by the consumer for technically classified rubber it is probably sufficient to obtain at least a tentative opinion of this system of classification by quite a number of manufacturers. Accordingly, an abstract is given below of

the document which carries the approval of the technical committee of the Federation of British Rubber Manufacturers Associations' and is referred to towards the end of the preceding subsection.

"Manufacturers require technically uniform rubber. The Technical Sub-Committee approve the steps already taken to achieve uniformity by technical classification, which they hope will be extended to all R.M.A. grades, including remilled rubbers, as rapidly as possible."

News Sheet No. 5 of the International Rubber Research Board shows that market trends have now led, from time to time, to the development of a small differential of the order of 1% of the selling price in favour of technically classified rubber as compared with unclassified material of the same R.M.A. grade. However it has been emphasised in the literature that if technical classification is to be of real value to the consumer, the volume of technically classified rubber on the market must be sufficient to allow the consumer to turn at least some of his processes to whole-time rather than intermittent use of technically classified rubber.

In the original scheme of classification, information on the Mooney Viscosity of the raw rubber and on the modulus of the rubber (compounded according to the A.C.S. No. 1 recipe, vulcanised for 40′ at 127°C and measured at 600% elongation) was shown on the outside of the bales. Three classes for each characteristic were distinguished; thus, distinct marks were employed for each separate Mooney class with different colours to the marks to signify the modulus class. The Mooney Viscosity classification was suspended with effect from the beginning of 1953 and the present (August 1953) class limits for the remaining test can be found below:

Limits for various Rubbers

| Test Type | Blue | Yellow | Red |
|---|---|---|---|
| Strain | 49-67 | 67-91 | 91 and over |
| F100 | 8.00-6.40 | 6.40-5.30 | 5.30 and under |

(Test Procedure and Notes: (1) For both tests the rubber is now compounded according to the A.C.S. No. 1 recipe, cured 40′ at 140°C and the test result corrected to a compound Mooney value, Vc, of 40.

(2) The strain figure recorded is actually the % elongation of a suitably shaped specimen subjected to a stress of 5 kilos/sq. centimetre for 60 seconds at $28 \pm .3$°C i.e. 77 to 87.8°F.

(3) The F100 value is the stress in Kilos/sq. centimetre of a suitably shaped specimen when elongated 100% for 1 minute.)

The smallest unit of rubber sampled on the commercial scale is the bale, but due to the cost and time involved only a certain proportion of the bales making up the consignment of a single R.M.A. grade can be sampled. Since there is in general a distinct variation between the mean strain values of the different bales making up a single consignment, it should be apparent that when the mean strain of the whole consignment is near the border of 2 classes (say at 65 see table above) then a considerable number of the bales will have strain values placing them in a class different from that of the bulk of the bales. The system of marking to be employed in such circumstances (border-line

consignments) has not yet (as far as the R.R.I.C. is aware) been settled on an international basis.

The R.R.I.C. has only comparatively recently received the equipment necessary to carry out work on this subject so that no detailed clear-cut advice on the most simple method for the technical classification of the major part of Ceylon's rubber is offered at this stage. The situation in Ceylon is not identical to that in Malaya, since Estate packing of R.S.S. and blanket crepes for export is the exception rather than the rule in Ceylon. However on this basis classification of large and medium sized (by Ceylon standards) Estate produced R.S.S. may be possible by one or more of the following schemes:—

(a) No technical classification grading on Estates; complete blending across or within Estate deliveries as required by the Packers.

(b) An approximate technical classification grading on certain Estates where the R.S.S. might be blended within deliveries; selected lots of deliveries blended by Packers according to the approximate technical classification grading of the Estates and consumers' requirements.

(c) Carefully controlled production on certain Estates with restricted variation between and within days; very restricted or no blending across different Estates' deliveries by Packers.

One of the major requirements of scheme (a) is that the Estate shall not produce too much rubber outside the limits envisaged in the technical classification system, in particular the mean strain value for the Estate should not be below, at or too near to 49 or if it is near to but above 49 the standard deviation between days and sheets must not be too high. Early experiments (T.C.B. 1., T.C.B. 2) suggest that this criterion can be met and more detailed information will be available later (T.C.B. 7). For scheme (b) above, the variation in technical classification properties between Estates may be large provided the requirement mentioned above in connection with (a) is met, but the variation between days within Estates and possibly between sheets within days within Estates should not be too large. The information available at present clearly suggests that the standard deviation of mean strain values between days varies considerably between Estates. For scheme (c) the prime requirement is a low standard deviation between days. Successful operation of all these schemes presupposes that the Packing Companies have the space necessary to carry out such blending as may be required.

Scheme (c) with baling on the Estates is, in effect, that operated on Malayan R.S.S. Estates by the R.R.I. of Malaya. Where the factory is, for example, a large centralised factory, this system is probably the simplest and near the ideal. The rubber is not sold loose and thus avoids contamination during transport to the ports. Such blending between days as may be necessary is readily carried out in the Estate packing room but in general the variation between days can be kept reasonably low by careful control, and the variation within days for the large quantity of rubber produced per day is restricted by large scale bulking operations. Further, once the techniques of 'level changing' i.e. changing the value of the consignment mean from say yellow to blue, have been worked out, alterations in consignment means to meet consumers' demands can probably most readily be complied with on a large scale with the centralised factories. This does not however mean that technically classified rubber, as required at present, can only be supplied by large units.

Technical Classification of small Estates and Small-Holders' R.S.S. will almost certainly have to be done through the Packer, and for this purpose a small Estate is an Estate where the daily crop is too small to justify approximate technical classification grading either because of the cost or because of insufficient capacity of the test station. The prime requirement of such rubber is that it shall fall within the limits of strain value envisaged by the scheme; information on this point will be available in due course. The classification of all Dealers' R.S.S. and Estates' low grade R.S.S. will probably have to be treated like Small-Holders' and small Estates' R.S.S. Various experiments have therefore been started to ascertain whether additional deliberate blending is necessary in the Packing House in order to meet the uniformity requirement of technically classified rubber e.g. low standard deviation between bales within consignments of a single R.M.A. grade. More information on this point should be available by November.

Dr. Newton, Co-ordinating Officer for technically classified rubber for the International Rubber Research Board, suggested in the course of his address in Colombo last year that Ceylon's latex blankets might be suitable for classification. Since that time the Colombo price for latex blankets has declined very considerably in comparison with that for R.S.S. and as a result an increasing number of blanket crepe Estates have turned to R.S.S. production. From a survey of information supplied by 58 Estates producing some blanket crepe, it seems likely that only about a third of the latex blanket crepe is from Estates making the major portions of their crop into blankets, the remainder being from sole crepe trimmings and lace cuttings and from first fraction. The latex blanket crepe from large and medium sized Estates turning out blanket crepe as their major product could probably be classified by schemes (b) or (c) mentioned in connection with R.S.S. or by the system used in Malaya. Where the blanket crepe is made from the by-products of sole crepe, the situation may be more complicated since there is reason to suppose that blanket from first fraction will in general tend to be of higher modulus than blanket made from sole crepe trimmings. Experiments on this subject are now in hand.

To summarise, the present policy of the R.R.I.C. is that the Department concerned shall carry out such small and large scale tests as may seem necessary or useful in order that the R.R.I.C. shall be able to offer advice to Government or to the Planting Industry as a whole at such time that the commercial production of technically classified rubber is decided upon in Ceylon, or whenever such advice is required. Packing Companies, Agency Houses, Proprietors and Superintendents are therefore earnestly requested to give the R.R.I.C. every assistance in this matter, whenever such assistance is desired.

# "SOME ASPECTS OF THE RELATION BETWEEN REPLANTING AND MANUFACTURE"

## Expanded Introduction and Summary of the Main Paper

In this expanded Introduction and Summary there is not time for me to do more than mention a few of the points brought out in some of the subsections of the paper under consideration.

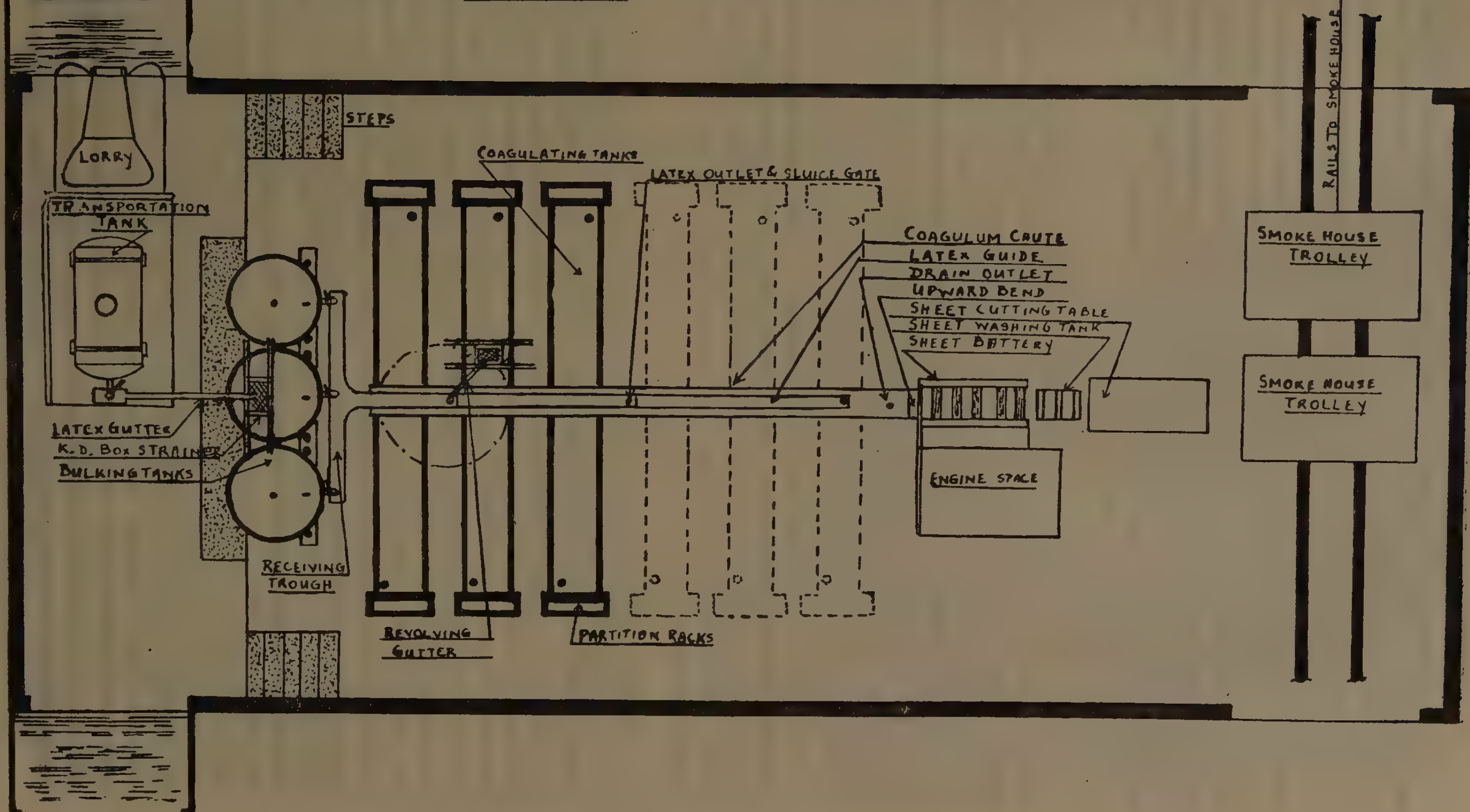
The theme underlying Section No. 2 is the question how far should the processing characteristics of the latex now influence the choice of planting material. Thus, in earlier years, Estates equipped only for crepe manufacture would be expected to give some thought to the colour of the latex, in so far that this governed the income possible from a pound of rubber in latex. With the application of fractional coagulation and the more recent discovery, in Malaya, of latex bleaching techniques, the picture has changed to some extent. However, while RPA.3 has undoubtedly been of great benefit to an appreciable number of Estates, large scale planting of material likely to give a very yellow latex is probably only worthwhile if the actual extra yield (compared to a white latex material) is sufficient to cover the small cost of RPA.3 and to overcome the risk that a higher % fraction may be desirable. The last issue of the Quarterly Circular discusses the use of RPA.3 in rather more detail. Planting material which produces, throughout the major portion of its useful life, a latex with a strong tendency to precoagulation can be at least a headache. The recent work, mainly in Malaya and Indonesia, on the theoretical principles involved has helped very considerably in understanding the background of the practical procedures carried out in the field. For example, it is reasonably obvious that under normal conditions the first application of anticoagulant must be made early in the manufacturing process, that is in the field by the tapper. The requirements of the latex concentrate manufacturer are discussed by H. M. Collier in sub-section 2(d) and Mr. Collier has quite clearly indicated that the concentrate manufacturer requires properly preserved latex, with if possible a low magnesium content. The first requirement, that is proper preservation, is largely a matter of internal organisation at the Estate concerned, and, it is too early for the R.R.I.C. to suggest all the clones in Ceylon which comply with the second requirement, that is low magnesium content in the latex.

The theme underlying Section No. 3 of the paper is that replanting will be expected in due course to give a substantial increase in actual factory loads, possibly beyond the rated normal capacity of the factory. Such loads could, if required, be processed by the construction of modernised and mechanised centralised factories built specially or built around existing factories, or by the sale of the excess crop to latex concentration units, or by other suitable means.

## SHEETING FACTORY LAYOUT TYPE "A"

3(c)-1.

FIXED TANKS



Messrs. Brown & Co's drawing facing page 12 of the preprint, (Slide No. 3 (b)-1,) shows the proposed layout for what is, in effect, a centralised blanket crepe factory. The basic points in the procedure are described by Mr. Wickham in Sub-section 3(b). I would, at this stage, draw your attention to the fact that the drawing shows what can be called a 'flow-line' or 'flow-through' method of manufacture. Where the main product of a factory is crepe there is, in many cases, likely to be little difficulty in processing the extra crop by multi-shift operation, although extra drying capacity may be required. The recent fall in the Singapore price of crepe compared to the Colombo price of sheet has led many crepe Estates to contemplate the installation of temporary or permanent R.S.S. production facilities. It is therefore proposed to deal in greater detail with certain aspects of R.S.S. production.

Typical R.S.S. factory layouts upto the stage of smoking are shown in Slide No. 3(c)-1, which has been redrawn from Messrs The Colombo Commercial Company's blue prints. This slide is based on fixed coagulation tanks, and illustrates a 'flow-through' method of manufacture for R.S.S. upto the stage of smoking. You will note that selection of coagulum according to 'feel' for milling purposes is facilitated in this arrangement and that the sheeting battery has 5 and not 4 pairs of rollers. Slide No. 3 (c)-2 is similar but involves the use of coagulation tanks on trucks.

As noted in the main text of the paper, two 4 roll sheeting batteries are manufactured in Ceylon—the Guthrie Cadet Prototype by Messrs. Brown and Co. Ltd. and the Cascade type Multiple Roller by Hoares (Ceylon) Ltd. Slides 3(c)-4 and 3(c)-4(a) show the Guthrie Cadet. Slides 3(c)-3 and 3(a) the Hoares mill.

Turning to the subject of drying and smoking of R.S.S. the basic steps involved are, in the simplest terms, firstly to get the water to the surface of the sheet, secondly to remove the water from the surface of the sheet either by drainage (that is by gravity) or by evaporation into the surrounding air, and finally to remove the dripped water and moist air from the smoke-house. We will deal with the last point now. If you fail to remove a reasonable part of the moisture in the drying unit the % relative humidity of the air in the unit will eventually build up to high levels, and at the worst you may find your sheets becoming mouldy and possibly the actual capacity of the house decreasing. (At this point I would like to define one of the terms used. The % relative humidity of a sample of air is the weight of water vapour in unit quantity of the air expressed as a % of the weight of water vapour which the unit quantity of air will hold when it is fully saturated. Under correct operating conditions, the difference between the wet and dry bulbs of the standard hygrometer is a measure of the % relative humidity, but the actual numerical value depends upon the reading of the dry bulb.) Slide No. 3 (c)-5 shows the relation between the apparent equilibrium moisture content, Me, of sub-samples of a single crepe lace and of a single sheet of R.S.S. and the % relative humidity of the surrounding air at room temperature. Under the conditions employed you will observe that the Me values for R.S.S. increase quite rapidly with increasing % relative humidity, implying that if the moisture content of the air in a

smoke-house is unnecessarily wet then the moisture content of the 'dry' sheets might be greater than could be obtained with a 'drier' smoke-house.

3 (C) - 5.

| Relation between Me, the % moisture content at apparent Equilibrium, and the % Relative Humidity. | | |
|---|---|---|
| Estimated % Relative Humidity | Me Values | |
| | Sole Crepe Lace | R. S. S. |
| 93 | ·13 % | (Mould) |
| 81 | ·10 % | ·94 % |
| 67 | ·09 % | ·58 % |
| 33 | ·04 % | ·07 % |
| 0 | ∽ ·01 % | ·00 % |

Further, since mould growth takes place at high moisture contents, it is also obvious that loose R.S.S. should be packed and despatched as early as possible from warm damp climatic conditions. Slide No. 3(c)-6 shows the relation between the time of drying of single small samples of crepe laces and the % relative humidity originally generated in a closed vessel at room temperature.

3 (C) - 6.

| Drying of very small samples of Sole Crepe Laces in a closed vessel (Mo ∽ 10%) | |
|---|---|
| Estimated % Relative Humidity | Estimated time required to reach M. C. of ∽ ·1% above Equilibrium Value |
| 93 | 46 Hours |
| 81 | 40 ,, |
| 67 | 37 ,, |
| 33 | 21 ,, |
| 0 | 10 ,, |

It should not be assumed, however, that the conditions necessarily approximate to those obtained commercially, nor that the total drying time of R.S.S. is necessarily equally dependent upon the % relative humidity in properly operated drying units. In the main text of the paper we have indicated that in conventional drying units, the % relative humidity is not generally independent of the temperature. Slide No. 3(c)-7 shows how the % relative humidity of given batches of air changes, simply as a result of heating the air. Column No. 3 shows the % relative humidity at the outside temperature and Column No.

4 the value at about the crepe lace drying temperature. If the figures were extended to the smoking range e.g., 120-140°F, quite low % relative humidity values would be found, implying that even if it is raining outside it is still possible to obtain quite low % relative humidities inside a smoke-house but that such low values could not be obtained in the present conventional lace drying units.

3 (C) - 7.

| Outside Temperature | Dew Point °C | % Relative Humidity at Temperatures Shown | | |
|---|---|---|---|---|
| | | Outside Temperature | 93·2 °F. | 102·0 °F. |
| 86° F (30°C) | 20 | 56·9 | 46·0 | 35·6 |
| | 25 | 75·9 | 61·3 | 47·4 |
| | 27 | 84·8 | 68·5 | 52·9 |
| 77°F (25°C) | 10 | 40·9 | 25·1 | 19·4 |
| | 17 | 62·9 | 38·6 | 29·8 |
| | 22 | 84·3 | 51·7 | 39·9 |

In this paper the drying period has been divided into at least 2 main parts including the initial 'zone of saturated surface drying' and the final 'zone of internal diffusion'. Slide No. 3(c)-8 shows curves of the moisture content of R.S.S. against time of drying taken from Piddlesden's work in J.R.R.I.M. Vol. 7 of 1936-7 page 123. You will note that the decrease in % moisture content for unit time interval is much faster at the beginning than at the end of drying.

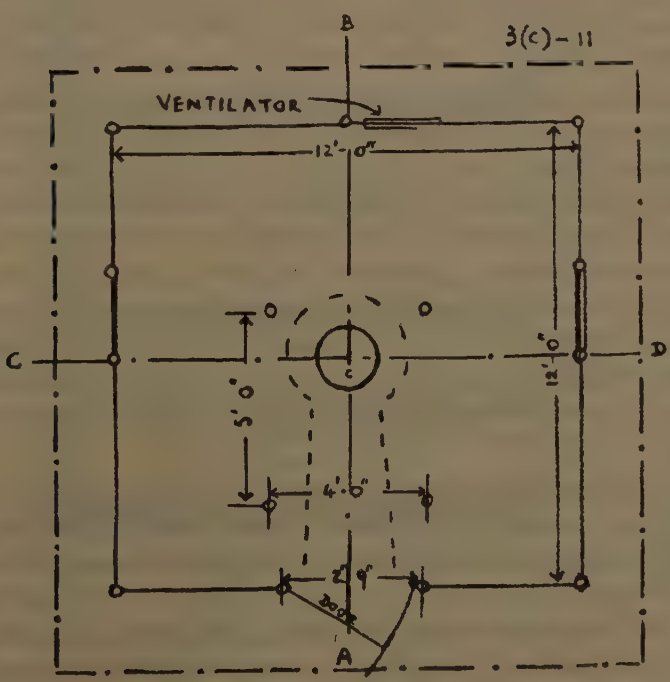
In the initial stages of drying the factors controlling the rate of loss of moisture are the ease with which the water may leave the sheet either by surface drainage or by evaporation into the surrounding air. The latter process depends upon the establishment of a high water vapour pressure difference between the surface of the sheet and the air in contact with it. You will recall that Slide No. 3(c)-5 suggested that the dependence of drying time upon the initial % relative humidity can be quite marked for crepe laces, under certain conditions. Therefore, since the rate of loss of water by evaporation is not expected to be entirely independent of the moisture content of the air in the drying unit, it may be questionable whether the dripping period should be unnecessarily curtailed, unless the smoke-house contains provision for removal of the dripped water by drainage gutters rather than by evaporation. This point is best illustrated by calculations (which will be produced elsewhere) based upon the conventional R.R.S. lace drying towers as these do not contain provision for removal of the dripped water other than by evaporation, so that insertion of almost completely undripped laces into one of these towers in wet weather could lead to an undesirable increase in % relative humidity depending upon the temperature, the weather, the ventilation, the weight of rubber inserted per day and the initial moisture content of the rubber etc.

Reverting to the subject of smoked sheet drying, the final stages (the zone of internal diffusion) are primarily dependent upon the temperature and the thickness of the sheet. Slide No. 3(c)-10 (ex J.R.R.I.M. 1936/7 7 125)

relates the thickness of the sheet to the time taken to dry R.S.S. from an initial moisture content of 10%, the estimated start of the diffusion controlled period, to near the equilibrium value. The units plotted are log 10 of the time in hours against log 10 of the thickness in thousandths part of an inch. The line has a slope of two and the points are the experimental points. The figures suggest that the thickness is related to the $(time)^2$ not to the time, so doubling the thickness will be expected to quadruple the time required. For smoked sheet drying, therefore, a change in thickness of the milled coagulum may well have a considerable influence on the total time taken to dry the sheets.

To summarise, we may say that under the appropriate circumstances the time of drying can depend upon the material itself, it's thickness and original water content on insertion into the drying unit, and upon the temperature and % relative humidity of the air surrounding the material. The design of the smoke-house and the procedure selected must make the most suitable compromise of these factors, be economical in operation and capital outlay, and must, of course, ensure that the heat and smoke can reach all the points required without unnecessary dead spaces.

I propose to show you slides of a number of smoke-houses taken from drawings or photographs in the literature. Slide No. 3(c)-11 shows a ground plan of an early temporary smoke-house (vide J. R. R. I. M. 1936/7 7 168.) You will note that this smoke-house, which has a stated capacity of about 1,600 lbs., has a single internal furnace and internal ground floor dimensions of 12′ × 12′. The R.R.I.C. has not built such a unit and I feel bound to caution you that if the ground floor dimensions are very greatly extended there could perhaps be difficulties in distributing the smoke and heat sufficiently evenly. Slide No. 3(c)-12 is a sectional view of this smoke-house showing how the baffle plate is used to distribute the hot air and smoke.

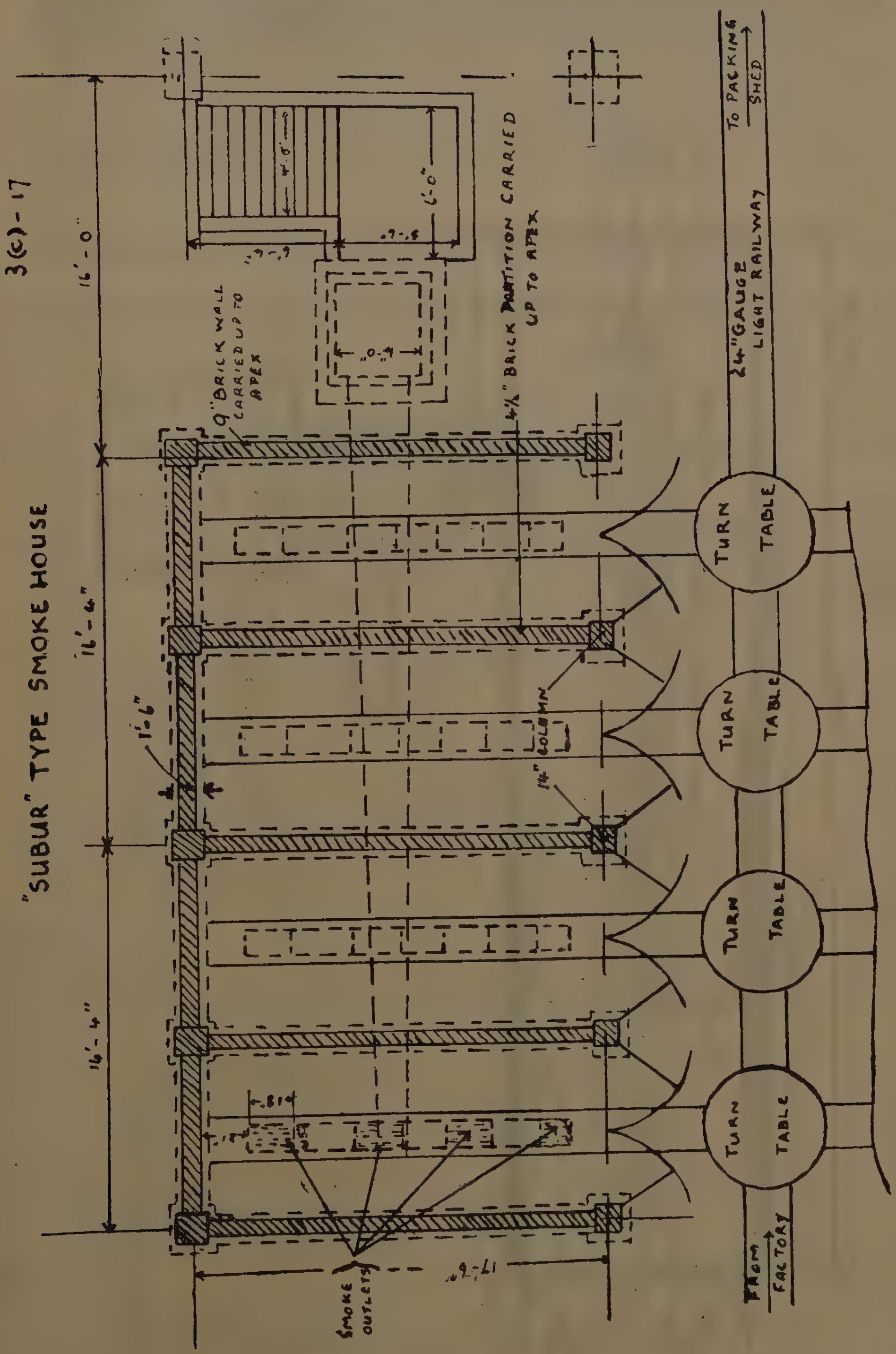



GROUND PLAN

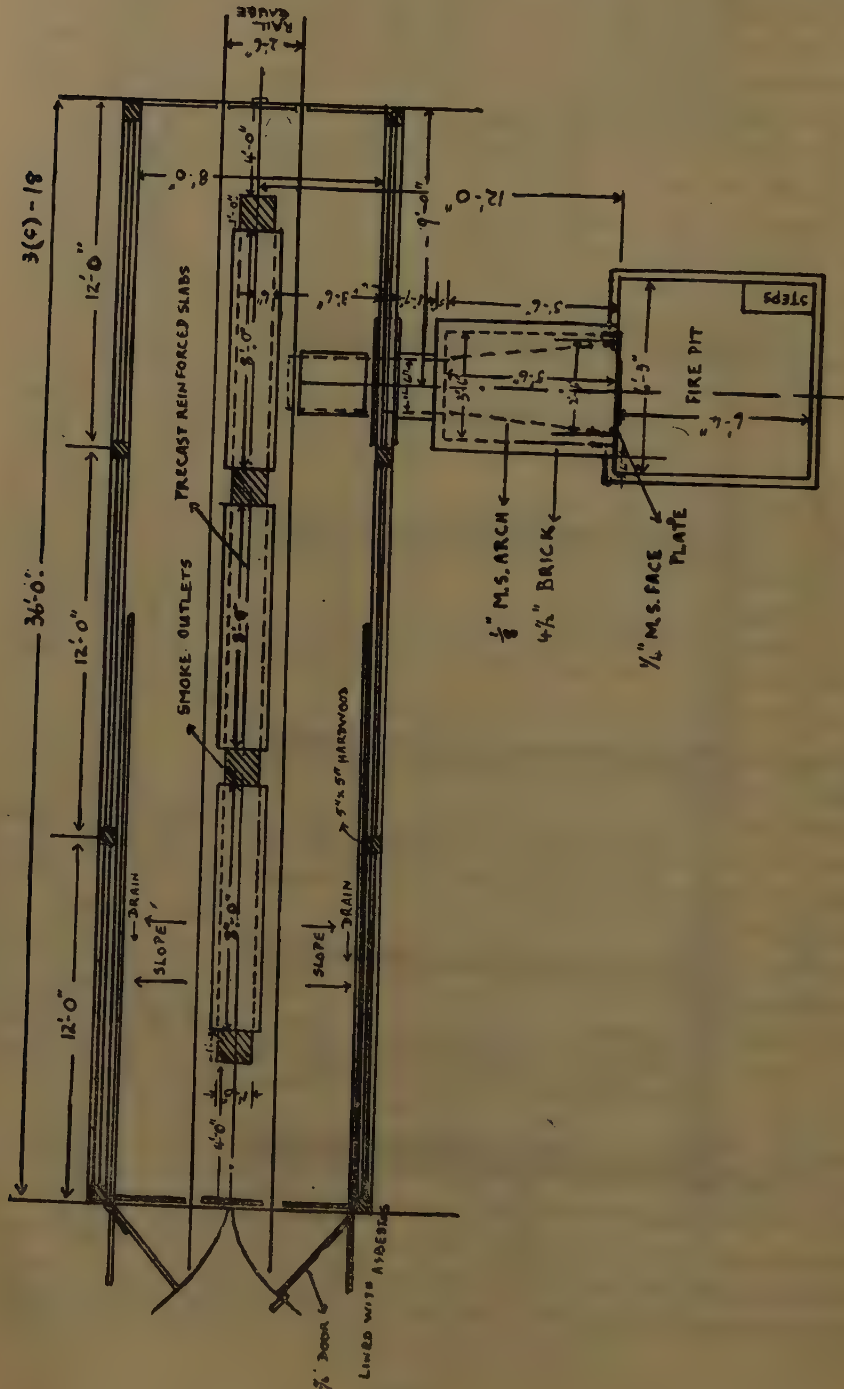
Slide No. 3(c)-13 shows a sketch of what is referred to in the literature as the 'Third Mile' type smoke-house with 2 views of the horizontal drum type furnace used with it. The furnace is fired from the outside. Slide No. 3(c)-14 shows a general view of a Double Devon type smoke-house. This has 2 distinct smoke-houses erected at opposite ends of a partially enclosed verandah or loading platform all under a single roof. The advantage of this unit is that the operation can be continuous rather that intermittent, as the racks are drawn out onto the loading platform for loading and unloading and the doors kept closed during the changeover of sheets. Slide No. 3(c)-16 shows a temporary type smoke-house called the 'Barker' smoke-house in which the wet sheet are mounted in racks at the higher end and proceed down the unit towards the furnace (in the brick compartment at the lower end). This movement takes place under gravity and the racks of dry sheets are removed by removing 'stops' so that the racks may slide out of the lower end. The novel and unique feature of this smoke-house is that by mounting a tank of water outside the lower end much of the material may be saved in the event of fire simply by knocking out the 'stops' and allowing the racks to slide into the water tank.

Most of you will be familiar with the conventional 'Kent' and 'R.R.S.' type units. The major defects of these units include a prolonged drying time or low capacity due to the fact that the temperature cannot normally rise to 140°F or more if the risk of blister formation is to be minimised and to the fact that the operation is discontinuous. These defects arise because wet sheets can be placed in the same smoking unit as and adjacent to nearly dry R.S.S. In the Subur type unit (J. R.R.I.M. 1936/7 7 154), shown in Slide No. 3(c)-17 the objections are overcome by having separate chambers for dry and wet sheets with a definite temperature difference between the various chambers, as stated in the main text of the preprint. The racks of wet sheets enter the left hand side compartment on the first day and proceed one compartment to the right each day. The furnace is shown to the right and the main flue from it is dotted. The ventilators and (smoke) flue outlets have to be adjusted separately for each chamber and extra air, as required, is obtained from ventilators (not shown) along the outside walls and doors. In a modified unit two furnaces are employed with separate flues to each chamber, so that each days crop could be kept for 2 days in an outer chamber before being moved into an inner one.

In the R.R.I.M. tunnel type smoke-house the individual chambers are scrapped in favour of a 'flow-line' or 'line-ahead' system. Slide 3(c)-18 shows a plan view of a unit designed for approximately 1000 lbs/day and illustrated in the R.R.I.M's Planting Manual No. 9 p. 21. The racks of wet sheets enter the tunnel at the 'cool' left hand side and emerge after about 4 days drying from the 'hot' right hand side. You will note that, although the normal dripping


3(c)-17
"SUBUR" TYPE SMOKE HOUSE
16'-0"
16'-6"
16'-4"
1'-6"
9" BRICK WALL CARRIED UP TO APEX
4½" BRICK PARTITION CARRIED UP TO APEX
14" COLUMN
SMOKE OUTLETS
17'-6"
TURN TABLE
TURN TABLE
TURN TABLE
TURN TABLE
24" GAUGE LIGHT RAILWAY
TO PACKING SHED
FROM FACTORY

takes place outside the smoke-house, provision is made (by means of the floor slope and the drainage gutters) for the removal of additional dripped water by methods other than evaporation. The smoke outlets and ventilators over the trolleys are adjusted to give the necessary temperature gradient inside the unit.



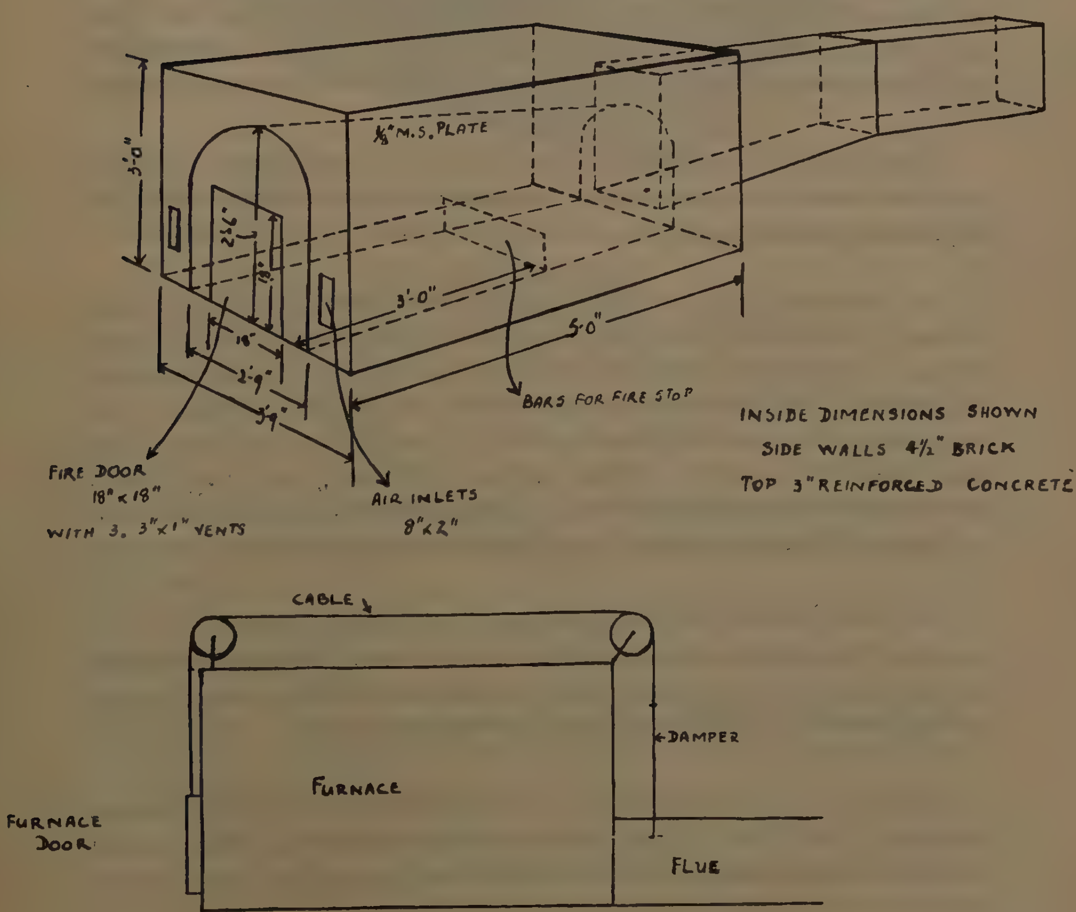
The type of furnace used with this smoke-house is illustrated in Slide 3(c)-19. A smoke-house of this basic design is under construction at Dartonfield and will be available for inspection under the normal terms of reference in due course.

Recently, the R.R.I.C. has had a considerable number of letters asking about smoke-houses and I think that it might be useful if I summarise again some of the basic points and principles involved in the design and operation of drying and smoking units. There are, at least 5 basic principles of operation:

1. Do not overload your smoke-house by inserting wet rubber at an unnecessarily high initial moisture content. This will not help and might do harm.

2. Coagulate at the correct d.r.c. for your mills, so that you do not produce an unnecessarily thick sheet.

PERSPECTIVE SKETCH OF METAL ARCH FURNACE 3(c) - 19



3. Operate your smoke-house at the correct temperature. For standard sheet the maximum permissible temperature depends inter alia upon the moisture content of the material and its thickness etc. With R.R.S. smoke-houses, the operating temperature is normally 120—130°F, depending upon the circumstances. The rate of diffusion of water vapour is very greatly dependent upon the temperature. Even if you have built a temporary smoke-house for Rs. 300 to Rs. 3000, do not forget to provide a thermometer.

4. Operate your smoke-house as near to continuously as possible, that is to do not permit the labour to spend hours inside changing sheet etc.

5. Ensure that there is adequate air inlet and smoke outlet space. Inadequate ventilation means that the moisture cannot leave the building and excess ventilation is liable to wasteful in fuel.

Regarding the construction of cheap smoke-houses, there seems to be ample scope for originality of design within certain basic limitations. The prime requirement is that the location of the furnaces, flues and outlets must be such that the smoke and heat can penetrate effectively to all the racks of sheets.

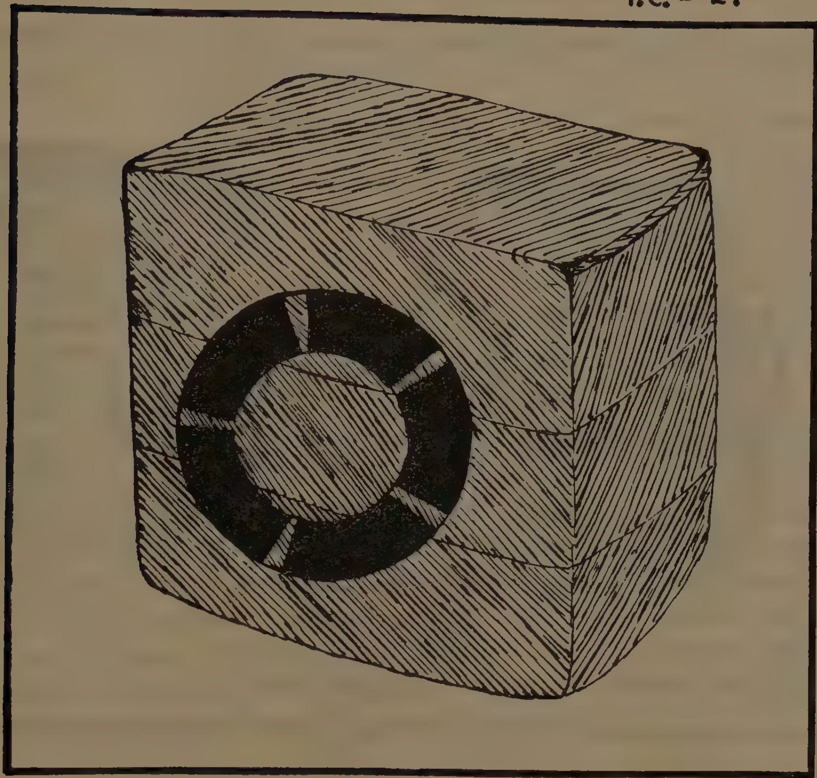
For the more permanent type unit, the R.R.S. smoke-house and the R.R.I.M. tunnel type seem, as far as I am aware, to be quite suitable under the appropriate conditions.

In Sub-section 3(d) Mr. Collier has described what a centrifuge does to properly preserved latex and Slide No. 3(d)-1 shows a diagramatic representation of a centrifuge. Section 4 deals with the disposal of rubber effluents, in particular with undiluted and substantially unammoniated serum. This work has at present reached the stage where it is possible for a number of common stream fish to survive without apparent difficulty in our final effluent diluted with 4 times its volume of water. None of these fish survived more than 1-2 hours in Dartonfield serum diluted with 10 times its volume of water.

The last subsection of the paper deals with certain aspects of the production of consignments of technically classified rubber. The individual bales of a consignment of T.C.R. have mean strain or modulus characteristics within certain limits when determined by a fixed procedure.

Slide No. T.C. 1 shows an estimate of the production of T.C.R. by various territories. Slide No. T.C. 2 shows a finished bale with its T.C. mark. I apologise for the poor quality of this slide which makes the original T.C. mark look rather like a life-belt, but perhaps it could be symbolic!

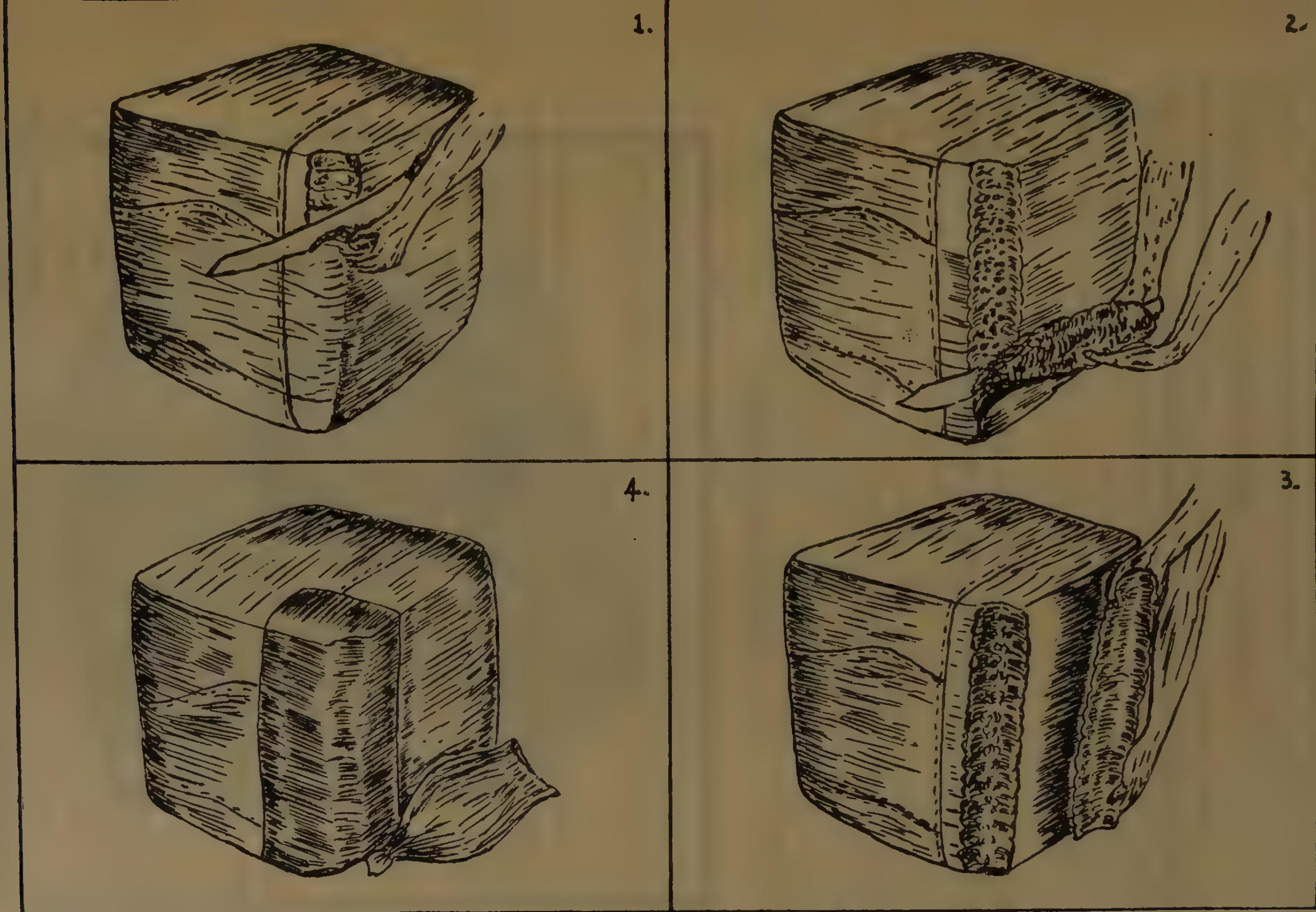
T.C. - 2.



A YELLOW CIRCLE BALE.

Slide No. T.C. 3 (redrawn from R.R.I.M's Planters' Bull, N.S. No. 2 p. 41) shows how the test sample is removed from a well pressed properly formed R.S.S. bale.

Slide No. T.C. 4 shows the most recently suggested (Nov. '53) class limits for the vulcanisation characteristic. The test used in Ceylon and Malaya is that in column No. 3 or 6 the figures being a % elongation.




1. Commencing The Sample cut.
2. Sample cut Almost Complete
3. Bale Sample
4. Repaired Bale and Labelled Sample Bag.

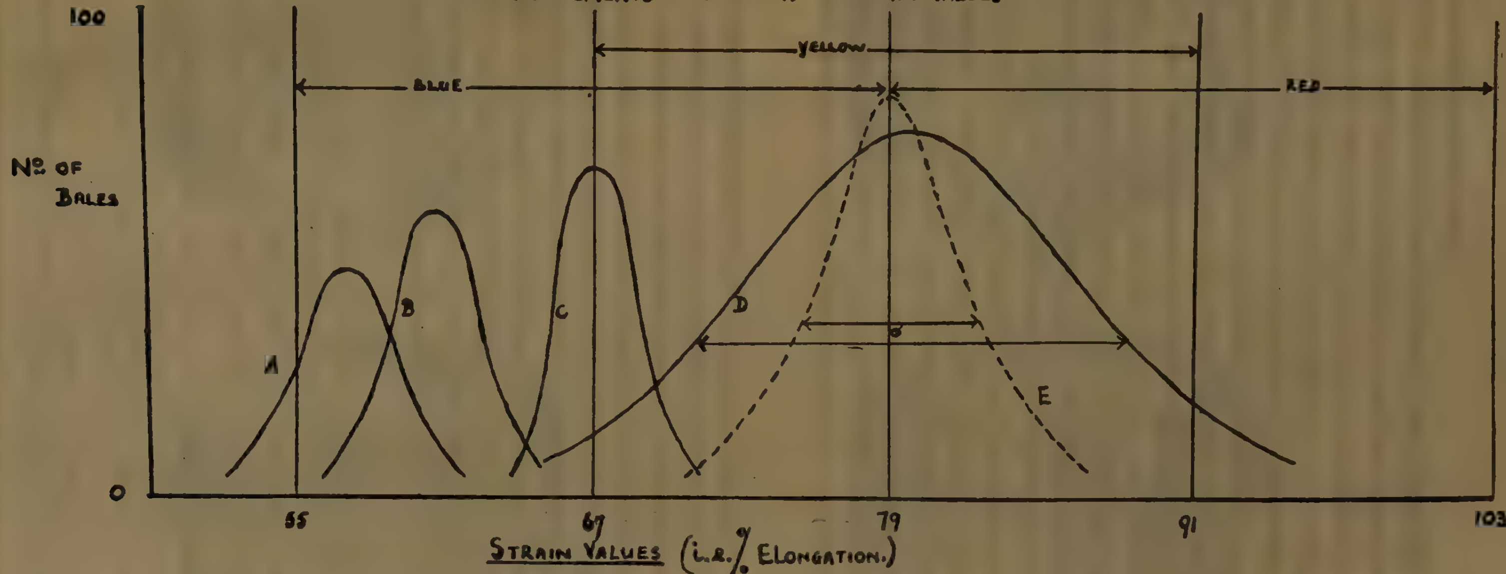
| Technical Class | Class Limits | | | T. C. 4 | | |
|---|---|---|---|---|---|---|
| | Normal Test Method | | | Rapid Test Method | | |
| | F 100 | Strain | M 660 (Approx.) | F 100 † | Strain *J* | M 660 *J* |
| Red | 4·75 – 5·85 | 103 – 79 | 30 - 50 | 4.40 - 5.65 | 116.0 - 85.0 | 25.7 - 46.2 |
| Yellow | 5·30 – 6·40 | 91 – 67 | 40 – 60 | 5.02 - 6.27 | 100.5 - 69.5 | 35.9 - 56.4 |
| Blue | 5·85 – 6·95 | 79 – 55 | 50 - 70 | 5.65 - 6.90 | 85 - 54·0 | 46.2 - 66.6 |

† I. F. C. & I. R. C. I. Experimental Results. *J* R. R. I. M. Experimental Results.

These class limits are illustrated pictorially in Slide No. T.C. 5, where the number of bales in a consignment is plotted against the mean strain of the bales. You will note that by allowing the blue and red to penetrate the yellow the difficulty of border-line bales is greatly simplified. The limits shown are what are called the consumer acceptance limits for bales and not the limits for mean figures of the consignment. These limits become effective January 1st. 1954. On the basis of these limits which have only recently been circularised officially, it is apparent that the outer limits of the scheme are now 55 and 103 in terms of strain units and the first sentence of the penultimate paragraph of page 24 of the preprint should be amended accordingly.

Various possible methods of producing T.C.R. in Ceylon are discussed on pages 24 and 25 of the preprint. I do not propose to discuss these possibilities in any great detail now as all the necessary experimental evidence for Ceylon is not yet available. However, Slide No. T.C. 6 which is based on hypothetical but not entirely improbable data shows why blended packing of small Estate and Small-Holder's lots may be necessary in Ceylon as well as in Malaya. Thus, curves A to F show the hypothetical distribution of the strain values of R.S.S. in small Estates' lots supplied substantially unblended to the Packer as one or more Dealers' lot of R.S.S. Now, if the Packer bales the lots in the order of delivery, that is A, then B, then C etc. and each lot amounts to 2 or more bales, then the distribution of strain values for the bale samples could follow the dotted curve. But, if the procedure of rotational packing is abandoned in favour of blended packing that is, for example, by taking a few sheet from each Small Estates' lot into each bale of the consignment, then the distribution of the strain values of the bale samples in the consignment might follow the curve with the cross marks. From the information available from Slide No. T.C. 5 it is reasonably certain that, in this particular case, rotational packing would not readily give a technically classifiable rubber consignment, whereas blended packing might.

REQUIREMENTS OF T.C.R. - STRAIN VALUES T.C.S.

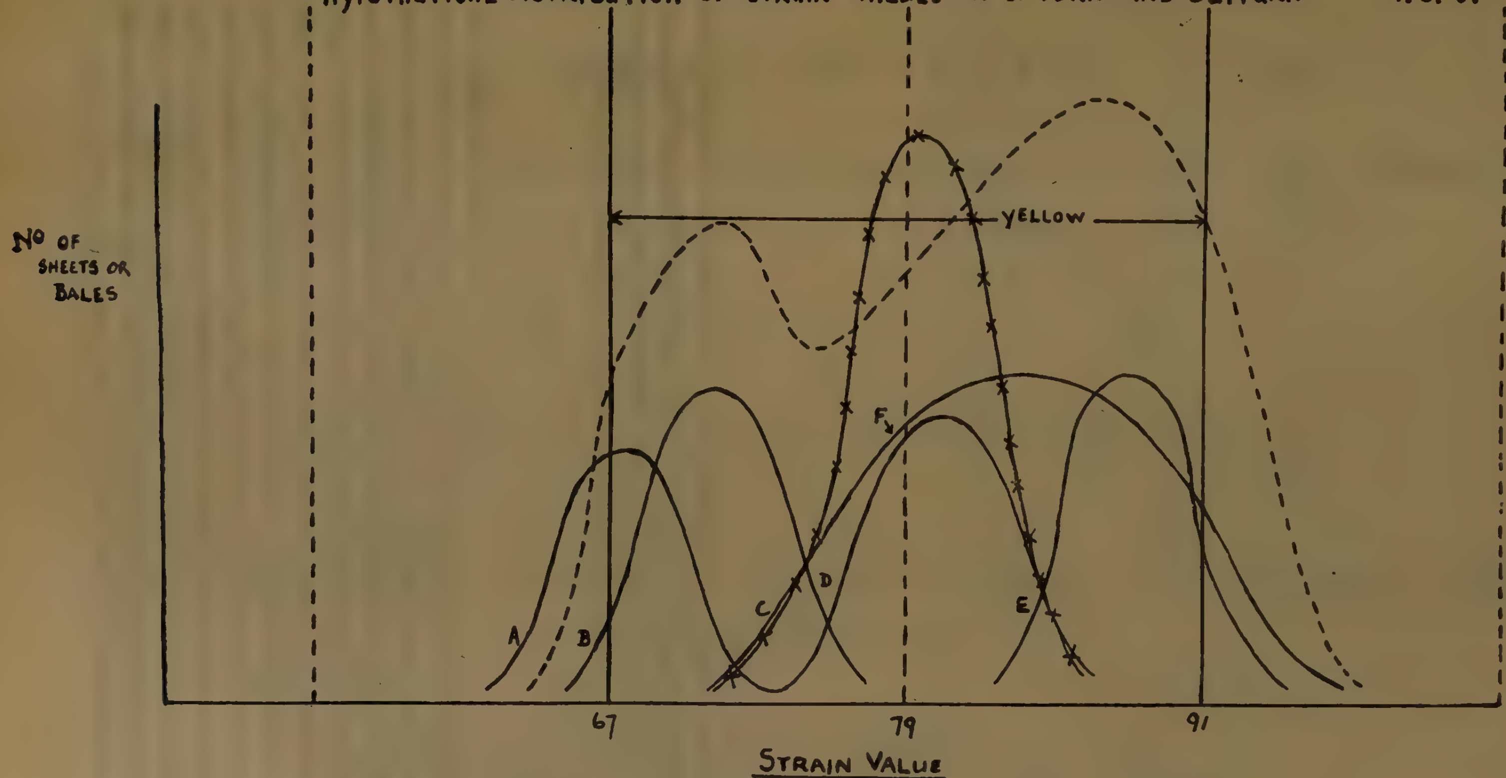



| CURVE No. | COMMENTS. |
| --- | --- |
| A | TOO HIGH A PROPORTION BELOW 55. UNSUITABLE. |
| B, C, E | SUITABLE FOR BLUE, BLUE, YELLOW RESPECTIVELY. |
| D | NOT SUFFICIENTLY UNIFORM. UNSUITABLE. (STANDARD DEVIATION TOO HIGH). |

There is one other point on this subject which I can, perhaps, usefully discuss, that is one reason why approximate rough grading at the large Estates could be desirable if these Estates do not pack T.C.R. under their own mark. Slide No. T. C.-7 is a hypothetical distribution of strain values of sheets in a Packers' stock, which consists of R.S.S. from large Estates, Ea, Eb, Ec and of Dealer's lots represented by the crossed curve. If the Packer wishes to supply only yellow T.C.R. it is probable that blended packing of all his stock could fulfill this requirement, but unless the Packer knows (at least approximately) the distributions labelled Ea, Eb, Ec it would be scarcely possible for him to supply blue or red T.C.R. Thus for red T.C.R., the R.S.S. from Ec could probably be used and for blue T.C.R. the R.S.S. from Ea alone or Ea blended with Eb might be used.

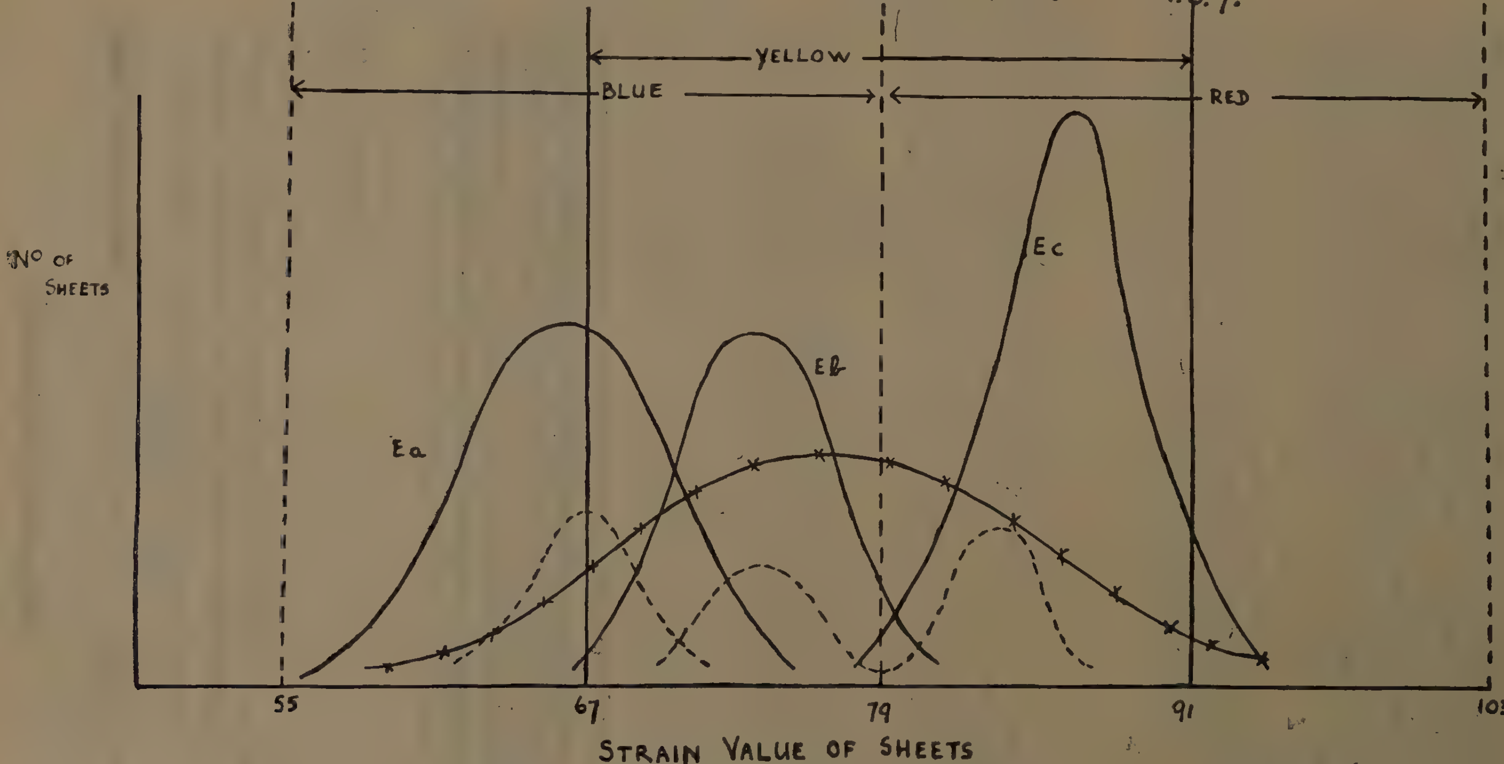
I would like to use this opportunity to thank the various persons who have contributed directly and indirectly to the various parts of this paper, either by submitting subsections at rather short notice or by carrying out much of the work described or by assisting in the preparation of the diagrams and slides.

HYPOTHETICAL DISTRIBUTION OF STRAIN VALUES OF INTURN AND OUTTURN T.C. 6.




1. FULL CURVES: DISTRIBUTION OF SHEETS FROM ESTATE UNITS A-F WITHIN DEALERS LOTS.
2. BROKEN CURVES: " " BALES BY ROTATIONAL PACKING
3. CROSSED CURVES: " " BALES BY BLENDED PACKING.

DISTRIBUTION OF STRAIN OF SHEETS IN PACKERS STOCKS T.C. 7.




FULL BLACK CURVES: DISTRIBUTION OF SHEETS OF LARGE ESTATES Ea, Eb, Ec. [——————]
DOTTED BLACK CURVES: " " " SMALL ESTATES INCLUDED IN [------]
CROSSED CURVE: " " " DEALERS LOTS [×××××]

**Mr. E. C. K. Minor**

Precoagulation: Has the tendency for precoagulation in the latex of trees which have suffered from heavy Oidium attack earlier in the year been reported to and investigated by the R.R.I.C., and if so, have the causes encouraging this been found?.

**Dr. E. J. Risdon**

The correct answer to this question is No. The connection between Oidium attack and precoagulation is not a subject with which I can claim great familiarity. If the foliage is not heavy there is a distinct possibility that the cups may be in direct sunlight, and if the leaf fall is about to take place the magnesium content of the latex might be higher than normal. Both these possibilities might tend to increase the severity of precoagulation.

# THE DIAGNOSIS OF MANURIAL REQUIREMENTS OF HEVEA

BY

**D. H. Constable, Agronomist.**

## PART 1.

### General.

There have recently been changes in the Institute's recommendations for manuring Hevea. These changes are, (1), the inclusion of more potash, to give a balanced mixture of composition similar to that of Hevea tissue, (2), the elimination of a special mixture for older trees, and (3), the adoption of "little & often" for applications to combat heavy rainfall and excessively porous soils. These recommendations have gone forth in the form of an Advisory Circular and have been discussed by the author at a number of P.A. Meetings.

It is not proposed therefore to go further into this subject which is likely to be static for a few years.

These recommendations are, however, very broad, as they have to cover all the rubber districts, all soils, clones, and elevations. It is reasonably obvious therefore, that this mixture will not be the optimum for all estates, although it is the Institute's opinion, that it is likely to give satisfactory results on a larger majority of estates than either R 215 or R 400 would have done.

Our aim therefore is to be able to make manurial recommendations by districts and finally even by estates.

It is the intention of this paper to outline the means by which this may be done and to describe what work the Institute is doing to this end.

## PART II

### Theory.

There are some six methods in normal use for diagnosing the manurial requirements of plants. These are, in order of importance, Field trials, Soil Chemical Analysis, Plant Chemical Analysis, Deficiency Symptoms, Soil Biological Analysis, Painting and Injection.

Field Trials are the ultimate test and proof of all manurial recommendations, for only field results can show whether a proposed mixture is actually satisfactory or not. In field trials of Hevea, however, we are up against the time factor. It takes 6-7 years before the tree is being tapped at all, then a further 10-15 years (according to tapping system) before renewed bark is tapped and proved to be in satisfactory condition. Therefore any doubtful mixture, such as only one or two out of the three major fertilisers cannot be considered proved until approximately 20 years work has been done. By this

time the soil has undergone a considerable alteration and depletion of its nutrients so that the mixture proved may no longer be suitable when starting from scratch. There are further practical difficulties concerned with organising such trials. In Ceylon the land does not favour the establishment of exactly similar size plots with equal number of trees in each plot. Such plots are, however, essential, if treatments are to be compared and effects, due to variability of ground and topography, tappers skill, variable rootstocks, etc. are to be eliminated or accurately assessed.

Then there is the danger of adjacent plots "poaching" from their better fed neighbours, and thereby reducing the differential between the best and worst treatments. Finally we come down to the difficulties of maintaining an even standard of tapping and of supervision to ensure no mixing of latex or "making up" tasks, addition of "cunje", thefts during periods of high prices, etc.

At this point it may be of interest to explain the underlying principle of all present day field trials. If you take any crop on any area of land however large or small, divide it into plots and measure any property of the crop, e.g. yield, girth, height, etc. you will find each plot varies from its neighbour. If then you are comparing two treatments (manures, tapping system, weeding, etc), you need to know if the difference found is no more than that due to natural variation or whether it is significantly greater.

Therefore you establish several plots (replications) of each treatment and from these you get not merely an average result for each treatment, but also the variation in the results which go to make up the average. Then you can form a mathematical estimate of the possible natural error of each treatment figure and see if the differences between treatments lie outside this possible error and if so to what degree. This degree is called the "significance" of the result and is expressed as less than 19:1, 19:1, or 99:1 probability (not significant, significant, or highly significant respectively).

A general drawback to Field Trials is that they must always be limited in size, and in numbers of trials, and it is desirable to have some check on the areas between trials which may or may not be on exactly similar soil types. At this stage Soil and/or Plant Analysis comes in. The former is more suited to annual or short term perennial crops and the latter to perennial crops. Both must be conducted in conjunction with Field Trials as the problem is to obtain a relationship between figures obtained by analysis and the actual results in the field.

Considering firstly soil analysis, we have said that this is more suitable to short term crops. One of the main reasons for this statement is that such crops are relatively shallow rooting and the collection of samples of soil from the entire feeding volume of the plant roots is a simple matter. Again analysis (and hence recommendations) can be made before planting, so fertiliser application can be made at the earliest stages, an essential point with crops maturing in from 60-120 days.

This matter is of far less importance with a perennial crop where a good dose of mixed fertiliser will be applied at planting and adjustments can be made later in the life of the plant, a method which would be neither economic nor possible in most annual crops. In the case of Ceylon, there is a further drawback that most rubber soils are impoverished and eroded, and the amounts of nutrient found are so small as to render the method of little comparative value for diagnostic purposes.

Here reference may be made also to the phenomenon of "fixation", which is of particular importance in phosphate manuring and sometimes of considerable importance in potash manuring. Where fixation occurs the added fertiliser frequently can be found in three forms in the soil, one, which appears, readily available to the plant, a second, which is available only with difficulty to the plant, and for which different plant species have varying powers of extraction, and thirdly, a form completely unavailable to the plant. In phosphate manuring it is very rare to recover more than 30% of the phosphate added and the recovery rate may be as low as 10% (Hence in calculating R 4:6:5 we multiply the theoretical amount of phosphate needed to get a balanced mixture 4:2:5 by three). Another result of "fixation" is that where the fertiliser is spread thinly on or in the soil it is obviously more liable to fixation, whereas, in "pockets" the effect is less as the localised proportion of phosphate to soil is very high.

Finally in this survey of soil analysis, and arising out of the "fixation" problem, there is the difficulty of assessing the availability of a nutrient to a given crop, Obviously if different crops have different abilities to utilise, say, phosphate, then, for the same amount of phosphate in the soil, different crops will give different results. Again, that same amount of phosphate is in three different states as far as we are concerned i.e. Available, Difficult and Not Available and we have to try and distinguish these three BIOLOGICAL states by CHEMICAL means. Even the description "difficult" may be a relative one in that with a short term crop, or when needing a "booster" dose for a long term crop, it may be of little use whereas the perennial crop, given plenty of time, may be able to utilise all of it without difficulty. As a result soil analyses have to be correlated with field experiments until a method of analysis is found which gives the best *average* agreement between actual nutrient needed and theoretical nutrient calculated from analysis figures.

We therefore turn next to plant analysis which in general is restricted to leaf analysis.

In leaf analysis we proceed on the assumption that if anything is wrong with the leaves it will be reflected in the general health of the tree. The majority of the metabolic processes of a plant take place in the leaf, and the presence of all the nutrient elements in sufficient quantities, is essential to the *complete* functioning of the leaf as a manufactory for the plant. Hence if we determine the normal amounts of each element in the leaf (by working on completely healthy plants) we should be able to determine for any plant of the same species whether it is obtaining a sufficiency of nutrient.

The main drawback to the method is that there is a fairly wide variation in content of fully healthy leaves, which can accumulate nutrients over and above their immediate needs. However the lower limit of satisfactory content, i.e. that below which deficiency symptoms occur, is fairly sharp for a given species, and it is usually simple to state when a tree is approaching or suffering from, under nutrition.

The method therefore is not suitable for attaining the optimum fertiliser mixture but it will show if the existing mixture is satisfactory (but not if it is unnecessarily "rich") or if a deficiency is starting. Further analyses will show whether remedial treatment (application of the deficient nutrient) is having effect or whether it is being "fixed" so that some other method of treatment is desirable. A great advantage then, to foliar analysis, is, that the effect of remedial treatments can be studied continuously, instead of having to wait a year or probably more for the effects to show up as increased girthing rates or

yields. Further, that it may be possible, (as in some other crops) to develop a quantitative relationship between the amount of fertiliser applied and the increase in leaf content and hence vice versa from the leaf content to determine the amount of fertiliser needed to restore the tree to normality.

We now come to the rather less important methods of manurial diagnosis, the first of which is the use of Deficiency Symptoms, alone or combined with Painting and Injection. From the point of view which we are taking, namely normal maintenance manuring, this has the disadvantage that the plants have to attain that stage of backward growth at which visible symptoms appear, which is rather a back handed way of pursuing our problem. Normally, deficiency symptoms appear in the leaves and growing points, as yellowing, discolouration, abnormal colouration, distorted growth and "die back". It is usual to study them by raising the plants concerned in pots, using specially cleaned sand, and to feed them on nutrient solutions minus one essential element. When symptoms of the type described occur, attempts are made to cure them by supplying the missing element. This element may be applied in the normal way or it may be painted (sprayed) onto the leaves or into cuts in the leaf or bark, sometimes by means of a container and a wick, sometimes by pills placed in holes bored into the stem. The painting method has the particular advantage that it may be confined to a few leaves, the effect on which can then be compared with other untreated leaves. A similar technique can be carried out in the field on trees exhibiting unknown symptoms and in this case different leaves are painted or injected with different elements, labelled, and observed.

That element producing a visible beneficial effect is then studied further. This treatment is also of value in cases of "fixation" mentioned previously, as, by direct injection into the tree, any soil effects may be bypassed within limits.

Having, by means of either the pot or field method, identified the symptoms of the various deficiencies, these are generally issued in the form of a descriptive pamphlet if possible with coloured photographs. Such a pamphlet can then be used by the planter in the field to obtain an approximate idea of his troubles and take immediate action.

Finally in this survey of methods for diagnosis of manurial requirements we have Soil Biological Analysis. In this method small quantities of soil are tested by growth in them of suitable plants to the point of cessation of growth due to exhaustion of one or more of the available soil nutrients.

It can be done on the macro or micro scale. In the former pots or buckets containing weighed amounts of the soil under examination are used. Large numbers of seedlings of a quick growing crop are grown in each pot till they start to fail. Simultaneously equal numbers of seedlings are grown in a pure sand culture. Both sets of plants are analysed and the difference in total nutrient content between the two sets is considered to be the amount of available nutrient in the soil. It has therefore the real value that a genuine estimate is obtained of the "available" nutrient in the soil. Its drawback is that it is suitable only for crops which can be grown in small pots, and of which the whole plant can be analysed without difficulty.

The microscale method is similar in principle but the work is carried on with very small quantities of soil in glass in the laboratory and the plants used are fungi generally *Aspergillus Niger*. This micro method is of particular value in dealing with the real micronutrients where the amounts of nutrients needed may be of the order of one ten millionth of the plant weight.

## PART III

### Practical

In the foregoing section we have summarised the methods available to us for determining manurial requirements. We have in addition shown the drawbacks of these methods so that planters may appreciate the limitations of the work when asking for advice. We now proceed to a description of our present work and of results to date.

Firstly, as to field trials, we have had three of importance to our discussion at the R.R.I., one of which is still under observation. This is the NPK trial which has been going for fourteen years. In it we have found that N and P both exert a significant effect on growth, the former being worth 1 inch extra girth in 14 years, and the latter 3 inches extra girth in seven years. On yield phosphate has given 135 lbs. per acre per year more, N 13 lbs. per acre more, and N plus K 59 lbs. per acre more than no manuring. The first and last results are significant. Difficulties in obtaining accurate yield figures by a sampling technique probably account for the lack of significance in the N yield figures.

However the increased girthing is a sufficient reason for advocating the inclusion of nitrogen.

Another experiment was one of using three different rates of nitrogen application in which no significant result was obtained. The highest level of nitrogen actually gave 10% (82 lbs/acre) more than the lowest but this is ascribed to natural variation.

The last experiment was one of broadcasting, pocketing and forking manures. Forking gave the best results (79 lbs/acre extra) but not significantly so. On the other hand with the best clone, forking gave 600 lbs per acre more, and pocketing 400 lbs/acre more, than broadcasting, a result which appears to be outside the expected natural variation.

Further manurial experiments have been opened at eight commercial estates throughout the rubber growing districts and at Hedigalla. They test the treatments Nil, P, PN, PK, and PNK using quantities approximately the same as the R. 4:6:5 mixture. It is too early yet (18 months) to make very much of a pronouncement. However we have girth figures for all of the estates which are shown in Table I.

*TABLE* 1.

*Girth in inches. Manurial Experiment* 1953.

| | Epping Forest PB 86 | Hewagam WG 6278 | Degalessa PB 86 | Ambatenne KPCS | Ederapolla PB Seed | Kepitigalla KPCS | Lochnagar KPCS | Mirishena GL I |
|---|---|---|---|---|---|---|---|---|
| O | 4.91 | 6.25 | 4.65 | 10.82 | 5.51 | 3.81 | 3.34 | 3.93 |
| P | 5.17 | 6.20 | 4.67 | 12.00* | 5.79 | 3.88 | 3.40 | 4.41* |
| NP | 5.36 | 6.92 | 5.25* | 12.46* | — | 4.18* | 3.51 | 4.56* |
| PK | 6.31* | 6.43 | 4.68 | 11.74 | — | 3.83 | 3.44 | 4.39* |
| NPK | 6.33* | 6.51 | 5.48* | 12.82* | 6.43* | 4.30* | 3.43 | 4.84** |

An asterisk indicates a significant result.

On six of the estates NPK has significantly improved the girthing. On four of these NP has proved nearly as good as NPK and on two of them PK is nearly as good as NPK.

On two of the estates there is a significant N effect (i.e. NP is better than P and NPK than PK by a significant amount) and on one a significant K effect (i.e. PK better than P and NPK better than NP).

On those two estates (Ambatenne and Mirishena) showing little difference between P, NP, PK and NPK the experiment was started after one year's ordinary manuring. It is likely therefore to be some time before the effect of this is lost and the full effect of the experimental treatments is felt.

Two estates have given no results to date. As the Matale estate has only had 15 inches of rain in the first half of this year this result is not surprising, while on Hewagam there has been bad rat damage and here it is interesting to see that they preferred the bark of fully manured trees. This incidentally illustrates the difficulty of maintaining field trials. In this particular case due to near ringbarking it is probable that the manured plots will receive a severe set back compared to the unmanured plots and no apparent difference in manurial effects may be the result.

Concurrently our laboratory work is on leaf analysis for reasons given in Part II. Our first task is to establish the average amounts of each nutrient in healthy trees and also the probable variation of the individual results from the average.

We are using for this purpose the NPK plots on each of the commercial estates and at Hedigalla, also the budwood nurseries at Nivitigalakele. Thus for PB 86 we have samples from Degalessa. Epping Forest, Nivitigalakele, and Hedigalla, while for Kepitigalla Polyclone seed we have Lochnagar, Kepitigalla, Ambatenne and Hedigalla so giving a wide range of comparison.

Table 2 then shows typical values for PB 86 and Table 3 for KPCS, while Table 4 shows typical values for other clones. The general inference to be drawn is that values for N over 3.5%, for P over 0.15%, and for K over .50% are probably satisfactory though there may be some variation between clones and due to the time of year. The last quarter of the year appears to give the highest results both for N and K.

At the same time we have been investigating typical deficiency symptoms where these have been brought to our notice. Values obtained are shown in Table 5 and there can be little doubt that distinct results have been obtained. Estate A is a very long standing case of yellowing leaves in which the stand took 11 years to bring into tapping. Some improvement in the leaves is now being shown though it is likely to be some time yet before this stand can recover.

Estate B suffers from yellowing in the last quarter of the year. It is on very poor soil and for some time was manured with Saphos only. It also receives only one manuring a year (at full rates) during the S.W. Monsoonal flush of leaf. Our diagnosis is that no fertiliser is left to supply the next flush of leaf which thereby draws its nutrients from the previous flushes, causing the appearance of deficiency symptoms in the older leaves.

Estate C is a hilltop planting, on the edge of the dry zone, at the rubber growing limit (rainfall). Although the estate is well looked after this PB86 is only giving 7-800 lbs. per acre, a suspiciously low yield. The yellowing of

the foliage on this hilltop is visible miles away and suggests nutrient starvation. In this case the trouble may be climatic but since the comparatively dry Moneragala district produces good rubber this suggestion is not a good probability. On this estate an experiment was laid down crossing NK manuring with lime manuring. The principal resultant figures are shown against the July analysis where it will be seen that a marked improvement has taken place in both N and K. What is better however, is, that on an area previously more or less completely yellow, there are now two green strips marking the position of the NK plots surrounded by yellow foliage on the other plots.

Estate D was a nursery (budgrafts) with some plants showing extreme yellowing of the leaves. Samples were taken from both yellow and normal leaves and the results given in Tables 3 and 4 were obtained.

There can be little doubt from these figures that it is possible to characterise some of the causes of deficiency symptoms and take remedial action. On the other hand if possible it is desirable not to attain such an extreme state.

It is hoped that continuous study of the Nil plots (on estate trials) and comparison with the NPK plots will show a decline in leaf contents on the former, possibly to the stage of deficiency symptoms. In any case the figure at which decline obviously starts may be postulated as the minimum satisfactory nutrient content for practical purposes.

We have therefore, at the sampling times and places shown in Table 2 and 3, taken leaves from the unmanured plots as well and we give some results in comparison with fully manured plots in Table 6.

Those values with an asterick are significantly higher, that is to say the difference between the values for O and NPK is greater, tested mathematically, than would be expected from natural variation. (A single asterisk is a 19:1 chance and a double asterisk 99:1). Two results will be apparent from this table, firstly, that in every case the NPK treated plots have leaves with higher nutrient content and secondly that in over half the cases the increase is significant, the results applying both to N and to K.

Following this the next step was to increase the number of treatments sampled and in May a start was made on O, P and NPK. In Table 7 the results for N and K on Kepitigalla are given as a typical example.

Both sets of results are significant at the 99:1 point and in both cases the NPK increase over P is significant at 19:1, while the P treatment has not improved the N and K values in comparison with the unmanured plot.

These figures enable us to illustrate the use of this work for diagnostic purposes. We have the result that NPK treatment has increased the N and K figures. From this we can say that at least one element is short; we cannot say more since a shortage of this element may influence the uptake of other nutrients to some extent.

We have also tried the effect of the P treatment and as this has had little effect, therefore we know that either N or K must be short, possibly both. The answer to which, and to the question of whether N shortage effects K uptake and vice versa, would be given by an analysis of material from the PN and PK plots.

It should be noted that these deductions hang on the postulate that the higher the leaf nutrient content the better for the tree. This is almost certainly true within limits, the only possibility (which we know does happen in many plants) being, that the tree may accumulate above its immediate needs, the so-called "luxury consumption". This however is not a bad thing in a perennial of this nature since it ensures a reserve stock against periods of starvation which may result during the economic crises which periodically effect the industry.

If at this stage you revert to Table 1 and compare it with Table 6 you will see that we have some confirmation of our ideas. Epping Forest has a very significant leaf potash 0.656 and 0.522 against 0.370 and 0.330. The girth figures also show a significant potash effect. Degalessa has a significant leaf nitrogen comparison of 3.40% against 2.50% and a similar girth improvement on both N manured plots so that on the two estates so far showing an N or K bias we have significant parallel leaf effects.

Extension of our analysis in due course to the NP and PK plots will, we hope, give similar results for those cases where the NP or PK girths have proved significant.

In any case it will be agreed that a prima facie case has been established for the potential value of this method of diagnosis being applied to Hevea.

## PART IV

### Trace Elements

We have said very little on this subject because there is at the moment no reason to suspect widespread trace deficiencies. On starting work at the R.R.I., the outline of research was planned on the basis that trace element research would be needed. However the discovery at an early date of the fact that there were definite shortages of Potash and Nitrogen, together with the other factors described in Circular No. 37, abruptly switched the emphasis to the major elements and to the problem of obtaining the correct basic nutrition for rubber.

## PART V

### Conclusion

We have therefore, a number of methods under active investigation and we hope that, in the course of this paper, the reader has obtained an idea of the possibilities to practical planting of the work being done. We would however ask planters not to rush off in search of deficiency symptoms and pour in requests for analysis.

Our first priority is to establish standard figures, and limits of satisfactory nutrition, before we can plan a general advisory set up. We shall however be pleased to hear from planters with *long standing* cases of deficiency symptoms, and we shall try to visit such estates in the gaps in our ordinary work. We do point out to such planters however that the work is, as yet, experimental and that they are offering themselves as "guinea-pigs". It is possible that this account may justify such a course to them.

Finally we should like to point out that the majority of this work is being done on young clearings and should be particularly applicable to the rehabilitation of rubber. It is a most important matter to give adequate nutrition to young plants and it is doubtful if damage due to neglect in the pretapping period can ever be satisfactorily repaired. To planters who are in doubt as to what mixture to use on a new clearing we commend the following thought:

"This clearing is to last at least 30 years and if any mistakes are made they may be permanent, and not just one season's crop lost". Is there any justification therefore for large scale experimentation by the use of unbalanced mixtures, or economy on quantities or methods of application? It is a safe generalisation for all forms of living matter that youthful malnutrition or ill-treatment can never entirely be rectified subsequently.

*TABLE* 2.

*Nutrient content in %ages dry leaf for fully manured PB86*

| Estate | Date | | Comments | N | P | K |
|---|---|---|---|---|---|---|
| Nivitigalakele | Sept. | 52 | Budwood | 4.38 | 0.20 | 1.06 |
| | Feb. | 53 | ,, | 3.81 | 0.20 | 0.76 |
| | April | 53 | ,, | 3.00 | 0.17 | 0.94 |
| Hedigalla | Mar. | 53 | NPK Expt. | 3.70 | 0.23 | 0.90 |
| | July | 53 | ,, | 3.54 | 0.17 | 0.77 |
| Epping Forest | Mar. | 53 | ,, | 3.64 | 0.19 | 0.66 |
| | May | 53 | ,, | 3.29 | 0.14 | 0.52 |
| | Aug. | 53 | ,, | 3.46 | 0.15 | 0.73 |
| Degalessa | Mar. | 53 | ,, | 4.18 | 0.22 | 0.73 |
| | May | 53 | ,, | 3.40 | 0.17 | 0.82 |
| | Aug. | 53 | ,, | 3.51 | 0.18 | 0.92 |
| Hewagam | Mar. | 53 | Rat damaged | 3.20 | 0.17 | 0.45 |

*TABLE* 3

*Nutrient content in %ages dry leaf for fully manured KPCS*

| Estate | Date | | Comments | N | P | K |
|---|---|---|---|---|---|---|
| Kepitigalla | Jan. | 53 | NPK Experiment | 4.10 | 0.19 | 0.72 |
| | Mar. | 53 | ,, | 4.32 | 0.15 | 0.38 |
| | May | 53 | ,, | 4.23 | 0.18 | 0.66 |
| Lochnagar | Mar. | 53 | ,, | 4.34 | 0.19 | 0.57 |
| | May | 53 | ,, | 4.40 | 0.19 | 0.77 |
| Hedigalla | Jan. | 53 | ,, | 4.00 | 0.19 | 0.76 |
| | Mar. | 53 | ,, | 3.80 | 0.23 | 0.66 |
| | July | 53 | ,, | 4.02 | 0.19 | 0.70 |

*TABLE* 4

*Nutrient Contents as %ages dry leaf for various fully manured clones*

| Clone | Estate | Date | | Comments | N | P | K |
|---|---|---|---|---|---|---|---|
| TJ. 1 | Nivitigalakele | Sept. | 52 | Budwood | 3.92 | 0.24 | 1.33 |
| | | Feb. | 53 | — | 3.81 | 0.21 | 0.93 |
| | | Apr. | 53 | ... | 3.70 | 0.17 | 0.67 |
| | Palmgarden | Jan. | 53 | Heavy Saphos | 4.30 | 0.35 | 0.71 |
| GL. 1 | Nivitigalakele | Jan. | 53 | Budwood | 4.00 | 0.21 | 0.70 |
| | | Feb. | 53 | | 3.70 | 0.19 | 0.69 |
| | | Apr. | 53 | | 3.70 | 0.15 | 0.60 |
| | Mirishena | Mar. | 53 | NPK Expt. | 3.10 | 0.20 | 0.73 |
| | | Mar. | 53 | ,, | 3.70 | 0.17 | 0.56 |
| | | May | 53 | ,, | 3.51 | 0.15 | 0.79 |
| | | Aug. | 53 | ,, | 3.64 | 0.18 | 0.93 |
| | "D" Also see Table 4 | Jan. | 53 | Nursery leaves | 3.65 | 0.19 | 0.96 |

## *TABLE 5*

*Nutrient Contents as %ages dry leaf—Suspected deficiencies.*

| Clone | Estate | Date | | Comments | N | P | K |
|---|---|---|---|---|---|---|---|
| MK 3/2 | "A" | Sept. | 53 | See Text | 2.36 | 0.13 | 0.17 |
| | | Nov. | 52 | ,, | 2.23 | 0.12 | 0.14 |
| | | Apr. | 53 | ,, | 3.50 | 0.19 | 0.38 |
| PB 86 | "B" | Nov. | 52 | ,, | 2.04 | 0.19 | 0.18 |
| PB 86 | "C" | Dec. | 52 | ,, | 2.51 | 0.22 | 0.25 |
| | | July | 53 | ,, | 3.79 | 0.24 | 0.73 |
| GL. 1 | "D" | Jan. | 53 | See Table 3 | 3.11 | 0.18 | 0.38 |

## *TABLE 6*

*Leaf Nutrient Contents as %ages of dried leaf resulting from different manurial treatments*

| | | Nitrogen March | | Nitrogen May | | Nitrogen August | |
|---|---|---|---|---|---|---|---|
| | | O | NPK | O | NPK | O | NPK |
| Mirishena | GL 1 | 3.60 | 3.70 | 3.16 | 3.51 | 3.60 | 3.64 |
| Epping Forest | PB 86 | 3.24 | 3.64 | 2.81 | 3.29* | 3.09 | 3.38* |
| Degalessa | PB 86 | 4.00 | 4.18 | 2.50 | 3.40** | 3.50 | 3.51 |
| Kepitigalla | KPCS | 3.46 | 4.32* | 3.40 | 4.23** | 3.10 | 3.77** |
| | | Potash | Mar. | Potash | May | Potash | Aug. |
| Mirishena | | .475 | .555* | .740 | .788 | .660 | .930* |
| Epping Forest | | .370 | .656** | .330 | .522* | .550 | .730* |
| Degalessa | | .522 | .730* | .710 | .815 | .670 | .920** |
| Kepitigalla | | .360 | .376 | .410 | .662* | .616 | .784** |

## *TABLE 7*

*Leaf nutrient Contents as %ages of dried leaf from different manurial treatments Kepitigalla May.*

| | Nitrogen O | P | NPK | O | Potash P | NPK |
|---|---|---|---|---|---|---|
| Plot 1 | 3.60 | 3.46 | 4.46 | .35 | .50 | .55 |
| 2 | 2.88 | 3.46 | 4.46 | .42 | .56 | .68 |
| 3 | 3.46 | 3.60 | 4.32 | .42 | .42 | .68 |
| 4 | 3.46 | 3.60 | 4.32 | .50 | .44 | .84 |
| 5 | 3.60 | 3.75 | 3.60 | .36 | .59 | .56 |
| Average | 3.40 | 3.57 | 4.23 | .410 | .502 | .662 |

## QUESTIONS & ANSWERS

**Mr. W. Nathaniel:** (1) What leaf material was used?

**Mr. D. H. Constable:** One leaf is taken from each tree and the entire centre leaflet used as material. Leaflets from 5 or 10 trees are bulked into one analysis sample. Such samples have a coefficient of variation of about 1% or less.

**Mr. W. Nathaniel:** (2) Have you tried out any rapid field tests?

**Mr. D. H. Constable:** No, our work at present is devoted entirely to establishing the total nutrient content of dry leaf tissue by wet digestion of oven dry material. Our next proposed step will be taken when the Research Assistant returns from his studies at the Waite Institute in Australia when we shall take up the field of soil analysis and try to correlate it with our results already obtained.

**Mr. F. G. C. Busby:** (3) Would organic manures help the fight against Oidium?

**Mr. D. H. Constable:** It is doubtful. Many advantages have been claimed for organic manures including better crops, more vitamin content, better health of people fed on crops raised on organic manures, more disease resistance of the crops. These claims have all been tested very carefully and it is the conclusion of the majority of Agricultural Scientists that none of them have been substantiated.

The average amounts of organic fertiliser needed are in the order 10-100 times that of inorganic fertilisers to give equivalent amounts of material.

There is no reason to think that manuring will combat disease but it must be remembered that under manuring will encourage it, so that proper balanced manuring with all elements in sufficient quantities is essential if a plant is to develop its maximum capacity for resistance.

**Mr. Cyril de Soysa:** (4) Does a plant derive benefit from manure in the planting hole? Is this not a waste and should not the manure be applied when roots have developed?

**Mr. D. H. Constable:** We recommend only Phosphate and/or well matured organic matter. Both these are resistant to losses by leaching and the single placement of Phosphate lessens "fixation". Consequently as the root hairs develop they have an immediate source of available nutrient which encourages quick growth. On normal crops it has been abundantly proved that placement of the fertiliser at the time of sowing, drilling or transplanting effects appreciable improvements on broadcasting or later manuring.

We recommend that Nitrogen and Potash be applied at 3-6 months when the plant is obviously well established.

**Mr. E. C. K. Minor:** (5) Why the expression "balanced" applied to a mixture like R.250?

**Mr. D. H. Constable:** The word balance is applied to any state of equilibrium. Agriculturally when applied to nutrients it refers to the proportions in which the elements are found in a completely healthy plant. This is the proportion then in which nutrients have to be supplied from the soil. If you assume that the soil is virtually exhausted, then this must be supplied by the fertiliser and any mixture formulated to supply approximately the balance of nutrients in the plant is a balanced mixture. This is still a fact even though in making up the formula it is necessary to make allowances for the known (or estimated) loss of any nutrient in the soil and to adjust the mixture accordingly.

**Mr. E. C. K. Minor:** (6) Why is it assumed that the manurial recommendations are likely to be static for several years?

**Mr. D. H. Constable:** Because we should be doing the industry a considerable disservice if we were to get into the habit of revising our recommendations every year or two.

Our attitude is, that until we can do individual analyses and determine the soil fertility in respect of each nutrient, we consider it better to advocate a mixture which is independent of the soil fertility (if any). In this connection I would remind listeners of the short life of the average chena cultivation as being indicative of the fertility status of even jungle soil.

**Mr. Alban E. Wijesekera:** (7) Could we not make out a prescription by examining the patient now?

**Mr. D. H. Constable:** Before you can examine a patient you must know what a healthy man looks like, feels like and sounds like. In order to say for example that such and such a body temperature indicates a fever you or somebody must have taken hundreds of temperatures from fit subjects. This is what we are doing for rubber in Ceylon at present i.e. finding the "normal temperature" for Nitrogen, Phosphorus, Potash, Calcium, Magnesium, Iron, and Manganese. When this has been done we can start "examining the patient" in earnest. To pursue the analogy we have also to be prenatal specialists i.e. we have to try and produce a healthy environment into which the new tree can be born and in which it can grow up.

**Mr. Alban E. Wijesekera:** (8) Density of planting.

**Mr. D. H. Constable:** Details of trial at Hedigalla.

# *TAPPING AND TAPPING SYSTEMS

BY

**C. A. de Silva, Botanist**

## Introduction.

The title covers the physiological aspects of tapping as well as the common systems of tapping adopted in this country.

In recent years we have planted a considerable acreage of clonal seed, which make it necessary to discuss tapping in connection with seedlings as well as budgrafts.

The experimental plantations of this Institute up to 1950 with blocks of very limited acreages of various types of planting material do not afford satisfactory conditions for carrying out large scale tapping experiments, and much of the information I have to offer is based on the experience gained from advisory work carried out during the past 10 years, and the results obtained on commercial plantations. We have also confirmed the results of tapping experiments obtained in outside countries with small scale experiments at Dartonfield.

## Tappable Bark

The word "bark" is used for that section of the stem, which has first the outer layer of corky tissue and inner layer of hard-bast which is characterised by its gritty texture, and then a soft-bast which has the tissue, which constitutes the most efficient latex producing section of the bark. The innermost layer next to the centre wood is the cambium, which is not much more than a millimetre in thickness.

When the tapping knife is used to open up the bark with a left to right cut the tapper opens up a number of cylindrical vessels running up the trees with a slight right to left spiral inclination. The cells, which normally are turgid, that is full like a bladder full of water, begin to exude the latex, until such time when the turgor or internal pressure is reduced. There is then a cessation of flow, the highly concentrated latex remaining in the cells coagulating to block the vessels. The latex is then collected leaving the last of the latex to coagulate on the cut, further sealing up the latex producing vessels.

The latex produced from the hardbast or outer layers of bark are different from the innermost cells. The dry rubber content is highest in the outer bark and decreases in the soft bast. The serum, nitrogen proteins and ash content are, however, lower in the latex of the hard-bast compared with that in the soft bast.

Very often in considering the intensity of tapping and yields of rubber, the loss of serum from the trees in the process of tapping is overlooked.

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The distribution of latex vessels in seedlings and budgrafts are different. In seedlings the number of latex vessels decreases on advancing higher up the tree. Budgrafts tapped at the same height show a much smaller variation for every inch rise in tapping. Experiments carried out in Malaya showed that for every inch rise in tapping cut above 20 inches, there is an average decrease of .25% for budgrafts compared with 1.6% for seedling trees. The height of tapping cut is therefore less important in budded trees than in seedlings with regard to yield and bark consumption.

In the case of budgrafts we find that, where high yielding scions have been grafted on to low yielding stocks, there is a certain incompatibility of laticiferous tissue, and latex vessels may end blindly on the union. It is generally found that a change in the general trend in yield may occur as the tapping cut approaches the union. Very often there is a fall in yield. The use of poor stocks can affect yields of high yielding scions up to 40%.

From the purely physical aspect we find that the girth of older seedlings at the base may be twice that at the height of 30 inches, while the girth remains almost the same at heights of 6 inches and 40 inches from the union in budded rubber. It is advantageous, therefore, to tap the seedlings for the longest period at the base for high yields from the greater concentration of latex producing tissues, and the greater length of the tapping cut, compared with tapping at 30 to 35 inches height.

The foregoing general conditions must be carefully taken into account in selecting suitable tapping conditions for seedlings and budgrafts for the production of economic yields.

**Tapping knives, spouts and cup-hangers.**

It will not be out of place in a paper dealing with tapping systems to comment on the correct use of tapping knives and collecting vessels. Every rubber grower is familiar with differences in yield of the same tapping task in the hands of two different tappers. The good tapper has a knife which is razor sharp, with which he taps with a single cut on each section of the bark, while the poor tapper goes over the same section many times when the latex is exuding, thereby lacerating the tissue and shortening the period of flow.

It should also be noted that a considerable amount of precoagulation between the field and factory will be due to latex buckets, which are not kept clean. Spouts and cup hangers have given considerable inspiration for the production of various types of these gadgets. The main point is that for budded trees, the lightest possible material should be used with spouts that will not penetrate more than four millimetres into the bark. On many estates the cups are left at ground level with the spout and the latex from tapping cuts up to maximum height run down the full height of the panel into the cup along a central channel. The chief objection to this is the high percentage of scrap rubber, which in some estates have gone up to 22%. This procedure for seedling trees is hardly necessary, where bark conditions are satisfactory for use of spouts up and down the tapping panel. In our clearings we still find a light spout and separate spring-wire cupholder most satisfactory for budded rubber and young seedling trees.

**Tapping Systems.**

The normal tapping systems in Ceylon are limited to five, which are straightforward, and the rest between tapping is confined to the immediate interval of tapping. The periodicity of the A.B. or A.B.C. systems of tapping

are rarely followed in Ceylon, such as tapping 6 months in 12, 12 months in 18, or daily tapping in alternate months.

I do not wish to dwell at length on the mathematical aspect of the International Notation System, which is clearly beyond the scope of this paper. Most planters are now familiar with the notation of the alternate half spiral system, expressed as S/2,d/2; (S) gives the fraction of the spiral, (d) stands for "daily", the period of tapping in the numerator, and the denominator gives the length of the cycle recorded in the same units as used in the numerator.

The actual intensity is $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$ cut per day, which is expressed as 100% by multiplying by 400.

The five tapping systems worked out in fractions × 400 are:—

(1) S/2, d/2, 100%
(2) S/2, d/3, 67%
(3) S/3, d/2, 67%
(4) 2S/2, d/4, 100%
(5) 2S/2, d/3, 133%

The number of tapping days on each estate, however, is an important factor when comparing the intensity of tapping on two estates. The following example will make the point clear:—

Estates A and B both use three systems of tapping the alternate day half spiral, the half spiral once in three days, and the double-three. Estate A has 280 tapping days, while Estate B has 320 tapping days. The intensity of tapping calculated on the two estates are as follows:—

*Estate A with* 280 *tapping days*

| | | Full spirals | Relative intensity |
|---|---|---|---|
| Alternate day half spiral system | $= \frac{1}{2} \times \frac{1}{2} \times 280$ | = 70 | 100% |
| Half spiral third-daily | $= \frac{1}{2} \times \frac{1}{3} \times 280$ | = 46.7 | 67% |
| Double-Three | $= \frac{2}{2} \times \frac{1}{3} \times 280$ | = 93.3 | 133% |

*Estate B with* 320 *tapping days*

| | | | |
|---|---|---|---|
| Alternate day half spiral system | $= \frac{1}{2} \times \frac{1}{2} \times 320$ | = 80 | 100% |
| Half spiral third daily | $= \frac{1}{2} \times \frac{1}{3} \times 320$ | = 53.3 | 67% |
| Double three | $= \frac{2}{2} \times \frac{1}{3} \times 320$ | = 106.3 | 133% |

The above shows that both estates are carrying out tapping systems which have the same intensity relative to the standard half spiral alternate day system within each estate, but the standard system on Estate B takes 80 full spiral cuts per tapping year compared with 70 full spiral in Estate A. In "actual" intensity Estate B is tapping 14 per cent more than Estate A.

These figures will make it clear that the various systems of tapping can affect the rubber in varying degrees, both in the production of latex and rate of growth according to the total number of tapping days per year. In this way overtapping can be carried out on many estates, although the relative intensity of the standard alternate day half spiral system still remains 100 per cent,

relative to the other tapping systems, within a single estate. Extra afternoon tappings which are not balanced for the year in keeping with the normal number of tapping days for this country and the use of rainguards, can contribute to over tapping, with the consequent repercussions, which were apparent in 1951 and 1952. Yield is always taken at the expense of growth and general vitality of the trees. The effects are more marked on young rubber than trees of 20 years and over.

**Tappability.**

The age of tappability in Ceylon is between 5 and 6 years for seedlings and between 6 and 7 years for budded rubber. The girth criterion for tappability in Indonesia is 45 cms at a height of one metre. This works out at 17.7 inches at a height of 3.27 feet. In general the tapping intensity is only 67% on 320 to 340 tapping days per year.

We recommend tapping both seedlings and budgrafts, when 70 per cent of the stand have reached a girth of 20 inches at a height of 3 feet from the ground and from the union for seedlings and buddings respectively.

I am aware that many agents insist on 22 inches for tappability. If there is an over-caution, it is certainly an error on the right side provided such a delay in tapping is in keeping with the economics of production on a particular estate.

We tap at 18 inches girth for early information on planting material in our experimental plantations. The original buddings of clone MK3/2, planted in 1928 were tapped at 15 inches, and they are still in tapping today. Over 25 years we have not seen any serious repercussions from bark diseases like Brown-Bast, which in many cases is a clonal characteristic of high yielding material. In recent years we have reduced this early test-tapping of 18 inch trees to a 67% intensity for the first three tapping years. The reduced intensity does not set back the rate of growth of young trees to the same extent as a 100% intensity tapping on S/2, d/2. I would certainly recommend this method of tapping on 67% for selective thinning of clonal seedlings planted at a high density. It is not always possible for estates to carry out the Morris-Mann system at about 4 years of age, and a stand of about 200 trees left over after early thinning on growth can be conveniently tapped at 18 inches on the reduced intensity for a final thinning out on yielding capacity on a per tree basis.

**The Tapper's Task**

The ratio of the tapping task for the single and double cut systems was 8:5 in the past, that is, 200 trees for the single cut and 125 trees for the double cut. This worked satisfactorily with the use of the Michie-Golledge knife. In recent years with high tapping costs every effort has been made to increase task size. In many cases it has been overdone resulting in a poor standard of tapping and yield returns below expected standards. Data from limited experiments offer little information for a successful solution of this problem. The topography of the rubber land is in most cases a limiting factor, and the man on the spot is the best judge of the size of tapping tasks to be allocated in the various fields. Recent developments in contour 'avenue' and "hedge" planting can afford facilities for increase of size of task on steep land, and every effort should be made to study the method of planting for ease of handling the trees for tapping. The maximum task size for satisfactory results in our own clearings have been 250 trees in the single-cut and 150 trees for the double-cut systems. The cost of tapping is inversely proportional to the yield output and size of tasks, and an

increase in the latter must be accompanied by a substantial increase in yield per task for economic tapping under present high costs of labour.

An over size task will cause an average number of trees to be tapped later in the day resulting in loss of crop, and such a task will also stimulate a tapper to tap in haste leading to irregularities in bark consumption and depth of tapping.

**Tapping Systems.**

There is not much choice in tapping systems for the first 3 to 4 years of tapping in young budded and seedling rubber in Ceylon. Consideration has to be given to poorer growing conditions compared with outside countries with regard to soil, climate, and incidence of disease, especially Oidium heveae, and Phytophthora.

Most clones with a tappable girth of 20 inches and over can stand up to 100 per cent intensity tapping with the single half spiral cut on alternate days (S/2, d/2, 100%), provided estates keep to the average number of normal tapping days of about 280 which include late tappings.

A tapping experiment with budded rubber at Dartonfield gave the following results in the second and third tapping years.

| Clone | Tapping System | Yield as a percentage of control S/2, d/2, 100% | |
|---|---|---|---|
| | | Second Tapping Year | Third Tapping Year |
| GL 1 | S/2, d/2, 100% | 100 | 100 |
| | S/3, d/2, 67% | 82 | 83 |
| | S/2, d/3, 67% | 92 | 101 |
| | 2S/2, d/4, 100% | 96 | 123 |
| AV 256 | S/2, d/2, 100% | 100 | 100 |
| | S/3, d/2, 67% | 77 | 79 |
| | S/2, d/3, 67% | 74 | 166* |
| | 2S/2, d/4, 100% | 113 | 125 |
| PB 25 | S/2, d/2, 100% | 100 | 100 |
| | S/3, d/2, 67% | 74 | 74 |
| | S/2, d/3, 67% | 74 | 163* |
| | 2S/2, d/4, 100% | 108 | 121 |

* Double-three tapping

In general a reduction in intensity from 100 to 67% is accompanied by a loss of 20 to 25 per cent of crop. This has been confirmed by large scale experiments in Malaya. With the same size tapping task the half spiral third daily at 67% intensity compensates for the loss in crop compared with the third cut on alternate days, which generally shows increased costs. Clone Glenshiel 1 is particularly adapted to the half spiral third daily system, which gives yields equivalent to the standard alternate-day, half spiral system.

If both systems of reduced tapping intensity at 67% give equivalent yields of approximately 80 per cent of the control, the relative costs on a tapping size of 200 trees on the single-cut system are:—

| Tapping system | Yield | Relative costs |
|---|---|---|
| S/2, d/2, 100% | 100% | 100 |
| S/2, d/3, 67% | 80% | 84 |
| S/3, d/2, 67% | 80% | 125 |

The advantage, is therefore, distinctly on the side of the half spiral third-daily system, if a reduced intensity tapping is necessary. There is also considerable difficulty in changing over from a third spiral to a half spiral on the tapping panel, which is tapped on the former for a number of years.

We have also recommended the double-four tapping on 100%, when the incidence of Brown-Bast has been checked in the first 3 to 4 years of tapping on a single cut system. On young budded and seedling rubber the double-four is capable of giving up to 20 per cent increased yields over the standard half spiral alternate day system. On old seedling rubber, the increased yield on double four was only 5 per cent over the control alternate-day half spiral in a 10 year experiment at Dartonfield. A considerable saving in tapping costs will be possible on double-four tapping on moderate yielding clones of vigorous growth.

In the Dartonfield tapping experiment clones AV256 and PB25 gave a 60% increased yields over control alternate-day half spiral, tapped on double-three introduced in the third year of tapping, without an unduly high incidence of Brown-Bast.

All high yielding clones, are susceptible to Brown-Bast, although in certain clones the incidence of this physiological panel disease is a distinct clonal characteristic. In the case of this disease the old adage is best "Prevention is better than cure". Over-extraction of latex will inevitably lead to dry-trees, which are incipient cases of Brown Bast especially during the first 3 to 4 years of tapping. At the present time high yielding clones with excessive Brown-Bast in the early years of tapping are not recommended for large scale planting. We have clones RRI. 506, and NAB 17 which are highly susceptible to Brown Bast. In recent years clone TJ. 1 has also become suspect on this account.

**Bark Consumption.**

The Michie-Golledge knife takes off about 1/20 to 1/25 of an inch per tapping. The thickness of bark taken depends to some extent on the tapping interval. In the wet low-country districts even a 4 day tapping interval does not dry the tapping cut, but such an interval in the Matale and Galle districts will present difficulties leading to thicker shavings of bark for satisfactory latex exudation. For this reason the double-four is not recommended for the drier districts. In the absence of the drying out of tapping cut, there is no evidence to show that increased yields can be obtained with thicker shavings. Owing to the greater height at which budded rubber can be tapped without heavy losses in yield, there is no great objection to higher bark consumption than the stipulated rates under the various systems of tapping, provided a renewal cycle of at least 8 years is allowed for bark renewal.

### Height of Tapping cuts.

The height of tapping cuts for any tapping system is based on the following rates of bark consumption per year of 240 tapping days.

| *Interval of tapping* | *Rate of bark consumption* |
|---|---|
| On alternate days | 6 inches |
| Once in three days | 4½ inches |
| Once in four days | 3½ inches |

Although an 8 year renewal cycle is sufficient, we normally take a 10 year renewal cycle, which gives bark consumption of 60, 45 and 35 inches for a single cut on the three intervals of tapping.

The alternate day half spiral system, S/2, d/2, 100% for budded trees will have 6 inches of untapped bark on each panel above the union which brings the total bark area required to 60 + 12 inches. The cuts are marked on two panels at a height of 36 inches, from the highest point of the union to the lowest point on the tapping cut. For seedling trees the corresponding height will be 30 inches on each panel from ground level.

The double-four 2S/2, d/4, 100% will have two cuts each with 35 inches consumption giving a total of 70 inches. With 6 inches of untapped bark on each panel for budded rubber the total bark consumption on two panels will be (70 + 12) inches. The cuts are, therefore, marked at a height of 41 inches for budded rubber and 35 inches for seedling rubber.

The tapping is, however, carried out at 41 and 23½ for budded rubber and 35 and 17½ for seedlings, thus keeping a maximum distance between the cuts. Our recommendations are that the height of cuts for the alternate-day half spiral can also be marked at the maximum height of 35 inches and 41 inches on each panel for seedlings and budded rubber respectively. This makes provision for a change over to the double-four, if the particular planting material can stand up to the double four in the 3 or 4th year of tapping and prevents the appearance of islands of virgin bark between the tapping cut and renewed bark in future years. These islands are inevitable, if new cuts are opened above the initial height of cuts. We have had evidence in the past that there is a danger of Brown Bast disease in such cases due presumably to incompatibility of laticiferous tissue in the tapped area. For the same reason it is necessary to change over the cut to the maximum height of the opposite panel on the alternate day half spiral approximately after 3 years tapping, if a change over to a double-cut system is contemplated in the future, changing over the tapping panel each year after this period.

We have two tapping systems of 67% intensity for disposal. The half spiral third-daily tapping S/2, d/3, 67% takes only 45 inches of bark for a 10 year cycle, which requires a height of 22½ inches + 6 inches on each panel.

The cuts should theoretically be marked at 28½ inches for budded rubber, and 22½ inches for seedling rubber. In actual practice it is best to mark the cuts at the maximum heights required for the higher intensities of tapping in the future, that is 41 inches for budded rubber and 35 inches for seedlings.

A third spiral cut on alternate-days, S/3, d/2, 67% divides the panel into 3 sections and 60 inches of bark required on a 10 year cycle is divided in to 20 inch bark consumption on each of three panels, marking 6 inches more for budded rubber at a height of 26 inches from the union. This system is not

generally recommended on costs of tapping, and other difficulties referred to earlier.

The double-three, 2S/2, d/3, 133% requires 45 inches on each panel, with a maximum bark consumption of 90 inches for a 10 year cycle, It is necessary in this case to reduce the cycle to approximately 8 or 9 years for both buddings and seedlings with the heights given for double-four tapping.

We can now summarise the heights of cuts for budded and seedling rubber as follows:—

| *Tapping System* | *Height of cuts in inches* — *Budded rubber from Union* | *Seedling rubber from ground level* |
|---|---|---|
| Half spiral alt. day (s/2, d/2) | 36 (41)* | 30 (35)* |
| Half spiral third daily, (s/2, d/3) | 28½ (41)* | 22½ (35)* |
| Double-four, 2s/2, d/4 | 41 and 23½ | 35 and 17½ |

**Slope of Cuts.**

The slope of cut is based on the condition of bark for tapping in budded and seedling trees.

The slope of the cut from high left to low right will be 25° to 35° from the horizontal for budded rubber. This enables the latex to flow quicker down the cut on bark, which is considerably thinner than seedling trees due to the absence of corky bark. At the finish of the panel the large triangle of untapped bark at the base is of little consequence, as the general trend of yields near the union tends to drop below normal in most cases, depending on stock-scion influence.

The angle of the cut for seedling trees will be 22½°. This provides for tapping on thicker bark, where there is less chance of over flow from cuts. Tapping can be taken down the panel to almost ground level, where the yields are almost double that obtained at 30 inches height, due to greater concentration of laticiferous tissue, and greater length of cut.

**Time of Tapping.**

This is a point in tapping which is too familiar to both the tapper and the rubber grower for lengthy discussion. I therefore, only refer to the physiological aspect of poorer yields obtained later in the day, compared with tapping carried out early in the morning almost before sunrise. There is almost a cessation of moisture loss from the trees during the night, thereby keeping the sap in the stem tissues at maximum internal pressure or turgor. This results in a quick and maximum exudation of latex. With the loss of water from the leaves with the advent of the sun and drier atmosphere the maximum turgor of the cells is lost, and exudation becomes slack, thereby resulting in a loss of crop. It is, therefore, necessary to see that the tapper gets to his task as early as possible on normal tapping days.

**Precoagulation of latex.**

This is a phenomenon of common occurence on tapping cuts due to more than one cause. In certain cases it is a clonal characteristic and the condition

*In actual practice cuts can be opened at maximum heights for tapping in the future on the double four system.

persists through out the life of the trees. In most cases it is due to the age of trees, and is noticed when the trees are first tapped. This usually rights itself after a few months of tapping. In many instances precoagulation occurs during periods of rainy weather. This can be effectively remedied by good estate sanitation methods. Once or twice a year all trees should be groomed by lightly scraping off all lichens and moss, which in rainy weather decay to give an acidic reaction to rain water running down the stem. The question of "hedge" and "avenue" planting may offer a solution here to keep the panels better ventilated and dry. These conditions reduce to a minimum the growth of flora, which is specially adapted to humid conditions, encouraged by heavy canopy of rubber leaves during the early years of tapping.

As a general estate routine for precoagulation a 1% solution of Ammonia has been used successfully on tapping cuts. A Sodium sulphite solution has been used, but it has not been popular owing to the quick deterioration of the solution on standing.

It will not be out of place to refer briefly to forms of test tapping used in connection with the planting of clonal seedlings, which as you know show considerable variation from tree to tree for growth, yield, and other secondary characteristics. There are two stages of early testing for yield, which have been used in recent years in many rubber growing countries. The first of these methods is the testing of seedlings for yielding capacity by test-pricking with Dr. Cramer's "Testatex" knife and the second method of early tapping with the Morris-Mann system.

The pricking-test method is done in clonal seedling nurseries, when the seedlings are grown up to 18 to 24 months before transplanting. Preliminary thinning out of "yellows", and runts can be done during the first year, and a final nursery stand of seedlings is used for test-pricking. The method can also be adopted for thinning out 2 to 3 plants per point in the field for a permanent stand of clonal seedlings in the field.

**Dr. Cramer's "Testatex" Knife.**

The knife is a simple device of 4 chevrons, which are pricked into the young bark of seedlings at ground level, and the yielding capacity is classified according to the flow of latex, ranging from a mere exudation of a bead of latex at points pricked to a flow down to the ground. Unfortunately no great relationship of these yields at maturity have been convincingly established in our experiments or those in Malaya. It is however possible to eliminate by this method the seedlings, which show little or no exudation at the pricking points in the nursery. Those who are interested in this knife can make enquiries for further details. A specimen knife is on show at this conference for those interested.

The Morris-Mann system of early tapping has, however, proved more successful when yields of trees of 12 inches and over about the 4th year of growth are compared with the yields of the mature trees.

This method is useful where a high initial stand of clonal seedlings is adopted for selective thinning out of poor growers and yielders at an early stage. The initial stand should be in the range of 250 to 300 points per acre for satisfactory results.

Tapping is carried out when about 80 per cent of trees have attained a circumference of 12 inches or more, just about the time when competition begins in high stands of rubber. The half spiral cuts are opened in the normal way at a height of about 20 inches from ground level with a steep slope of cuts, of 30° to 35°. About 250 to 300 tree tasks are allowed for 10 rounds of daily tapping in the morning or afternoon, during a period of favourable weather. The first 5 tappings are collected and discarded. Observations and records are made on the second 5 tappings. The latex is coagulated in the cups with a few drops of acid, and the coagulum is fastened to each tree with a wire.

If square planting is adopted, groups of 15 to 20 trees are taken at a time. Trees for elimination are marked out according to the proportionate figure required according to the extent of thinning. Normally it will be best to thin out 250 to 300 trees to a stand of 180 points per acre. It will be necessary to consider, yield, spacing and growth in the thinning out procedure.

To minimise the effect of unevenness, which is inevitable in dealing with a variable material as clonal seedlings, there is little doubt that "avenue" or "hedge" planting is adapted for irregular thinning out over a long period. 5′ × 35′ or 5′ × 30′ has been recommended as a convenient spacing for stands of approximately 250 to 300 points per acre. By this method a more even thinning out of the lowest yielders is possible, giving due consideration to growth and other secondary characteristics.

Finally I would like to touch on the question of yield stimulation with regard to tapping intensity and other related factors.

We have in recent years heard much about proprietary preparations, which give increased yields at short notice. These take the form of injections or applications on the tapping panel. Among many yield stimulating substances in the form of hormones, there are two which have been presented as proprietary preparations, "Eureka" and "Stimulex" The latter is better known and is available in Ceylon. Among injections copper-sulphate has been in the forefront.

What are the views of the R.R.I. in this matter. We have had considerable experience of stimulating yield during the war with coconut oil, palm oil, Mee oil, and even Cargilineum A and B with their oily bases. There is little doubt that such applications of 3 to 6 inches on the panel under the tapping cut can give greatly increased yields for short periods. The increased yield from "Stimulex" which is palm oil with a harmone is, therefore, not unexpected and there is little doubt that such applications can give increased yields. There is, however, the added claim that the "hormone" has also the stimulating effect on laticiferous tissue, which presumably prevents any undesirable repercussions from over extraction of latex during short periods of application.

At the present time we do not have any evidence of the long term effects of repeated applications at the recommended intervals. We cannot, therefore, recommend the large scale use of yield stimulants on our limited acreage of young high yielding budded and seedling rubber in tapping, especially at a time when a considerable acreage of old rubber is earmarked to go out of production.

We can, however, recommend the use of "Stimulex" on old seedling rubber, with normal system of tapping up to 133% intensity. It would be uneconomical to use such stimulants with slaughter-tapping. Application with normal systems of tapping can still preserve the trees for further tapping, while

slaughter tapping makes the elimination of the old stand a final decision. The application of stimulex for increased crop, on older poor yielding budded rubber is also permissible to a limited extent.

Recent indications on early experimentation with yield stimulation are as follows:—

**Copper-Sulphate Injections.**

(a) Damage to bark and wood, with the CuSo4 killing bark, cambium and wood.

(b) Cost of boring proves uneconomical.

(c) Latex may be contaminated with copper (over 8 parts per million causes softening and tackiness).

**"Stimulex" and "Eureka"**

(a) High yielding rubber produce an average increase of 20 to 30 per cent.

(b) 500 lbs. trees can give up to 75% increased yield in the first 14 months.

(c) The increased yields do not last more than about 3 months, with no falling below normal yields.

(d) No excessive Brown Bast from treatment.

(e) No information on continued treatment and repercussions if any.

(f) Late drip and late collections are inevitable.

(g) Great caution is necessary in dealing with new high yielding clones.

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## QUESTIONS & ANSWERS.

### YIELDS ON RENEWED BARK

**Mr. Cyril de Soysa.**

*Question:-* "Are yields on renewed bark of both seedling and budded rubber higher than those of virgin bark. On certain estates that I know of, the yield on renewed bark has come down, but there has been no drop in the yield of the original bark:

**Mr. L. C. de Mel.**

*Question:-* "Please tell us whether there are any foreign clones that have produced satisfactory yields on renewed bark in Ceylon".

**Mr. E. C. K. Minor.**

*Question.* "The question of tapping results on renewed bark is one which is of great interest to many estates now. Has a fall in yield been shown? Will this improve in time?"

*Answers.* In general the yields on renewed bark will depend strongly on the conditions under which the tapped bark is regenerated. The tapping

history, incidence of leaf and bark diseases, cultural operations and soil conditions will all be contributory factors.

Schweizer working in Indonesia 1929 - 1936 makes the following observations:—

The first regenerated bark was found to yield considerably more latex than virgin bark at the same height. The latex flow from second regenerated bark showed several irregularities.

The question of yields on renewed bark is particularly difficult to investigate, as tapping on renewed and virgin bark cannot be done on the same tree, nor on the same field, except on a different set of trees. The matter of selecting a comparable control is a practical difficulty. General observations of estate yields in a particular field on renewed bark in a particular year is totally inadequate to generalise on a question of yields on renewed bark for any particular clone.

The question of yields on renewed bark of foreign clones has not been specially investigated in Ceylon, except perhaps clone TJ. 1, in which the depression in yield in recent years has been attributed to Oidium. Most foreign clones are only just coming in for tapping on renewed bark.

In descriptions of foreign clones like PB86, AV255, PR107 the renewed bark is described as satisfactory and very good in the case of PR 107.

## TAPPING SYSTEMS

**Mr. L. C. de Mel.**

*Question.* "Do you consider S/2, d/2; as the most satisfactory system of tapping on budgrafts in Ceylon"?

*Answer:-* It is known that different clones require modifications in intensity of tapping to suit high yielding conditions. In general S/2, d/2 is satisfactory for tapping high yielding clones in Ceylon provided the actual intensity does not exceed 70 full spiral cuts per tapping year.

Long resting systems are unsuitable in a country where weather conditions for tapping from month to month and week to week are most unreliable, with two regular monsoons each year.

There is also the difficulty of a permanent labour force on Ceylon estates; long tapping-resting systems will present considerable difficulties.

A reduction in tapping intensity to 67% is always useful for clones which develop BB in the early years of tapping.

## THICKNESS OF BARK SHAVINGS

**Mr. R. J. Hartley** (**Comments**)

In Malaya it is considered bad practice to take off less than 9 inches of bark—(on alternate day tapping).

*Answer.* The bark consumption in Ceylon is based on the use of the Michie-Colledge knife as compared with the "gouge" or "Jebong" which cuts a groove, as a draw-knife and takes more bark per cut.

The 6″ per year bark consumption will depend on the number of tappings, and is given as a basis for calculating the height of cut for budded and seedling rubber for a given tapping cycle. At Dartonfield we have worked very close to this consumption without loss of crop, but 7 to 8 inches per year on budded rubber is certainly permissible.

In 1940 we carried out an experiment taking off ½″, ¾″ and 1 inch consumption per month on the alternate day half spiral and got no significant differences in yield.

In a recent publication by Dijkman who has reviewed the results of extensive experiments carried out by Mass, Schemole, in Indonesia and the Rubber Research Institute of Malaya, the findings are summarised as follows:

"The strip of bark that has to be removed should be such that all the latex vessels are re-opened each time a tapping is done. It has been found that it is undesirable to cut away more than is strictly necessary to open up these vessels." The bark consumption given for two day tapping interval is in accordance with the use of the "draw-knife" which takes up to 12″ per year.

In Ceylon the tapping task is much smaller than that adopted in Malaya, and with a flat cut,—thinner shavings of 1/25th to 1/20th inch thickness are possible and sufficient to open up the vessels in the wet low country areas. The question of bark renewal with poor soil conditions and incidence of leaf disease in this country is causing some anxiety as shown by questions on yields on renewed bark, and it is best to restrict bark consumption to the minimum required for efficient tapping.

**Mr. Hartley** (**Comments**)

We are also told from Malaya that taking thicker bark shavings means less Brown Bast.

If thicker shavings increases latex production, it cannot lessen Brown bast, which is a physiological disease attributed to over extraction of latex. We reduce our tapping intensity to 67% on the appearance of Brown Bast. There is, however, a theory that on the appearance of dry cuts, which is incipient Brown Bast, thicker shavings will take off the affected area. This did not work in practice in experiments at Dartonfield. It was found that when the cut shows the first symptoms of dryness, the characteristics lesions of Brown Bast have already spread downwards up to 2 feet on the panel.

**CHANGE OVER SYSTEMS**

**Mr. F. G. C. Busby**

*Question.* Have any experiments been carried out to discover which is the best method of tapping budded rubber as regards the change over from one side of the panel to the other?

*Question* 2. Is it better to tap right down one side of the panel and then change over to change over alternatively each year?

*Answer.* Normally a change over is unnecessary in budded rubber, unless a double cut system is contemplated in the future.

It is best to tap down one side and change over to the maximum height on the opposite panel.

If a change over system is to be introduced it can only be done conveniently about the 3rd or 4th year of tapping according to height of cut. A change over system from the commencement of tapping will entail a first cut on virgin bark halfway down the panel, which is undesirable.

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## CLOSING ADDRESS

BY

**Mr. W. P. H. Dias, J.P., Chairman, Rubber Research Board.**

Gentlemen,

We are now nearing the end of this Conference, and I would like to take the opportunity of expressing our thanks to the Planters' Association of Ceylon and its staff for providing this hall and for arranging the seating and their generally invaluable help in staging today's meeting. I would like to thank on your behalf the Tea Propaganda Board for providing us with tea during the intervals and the Ceylon University for providing the lantern and making the lantern slides shown today as well as operating the projector.

The attendance today has been most pleasing and I am sorry that for want of accommodation a number of late applicants for seating had to be turned away.

I feel that the interest taken in this Conference, as exemplified by the attendance and questions, is a yard stick by which the Rubber Research Institute's position in the thoughts of the industry can be gauged and I would like to congratulate the speakers on the high calibre of the papers they have put before you.

As mentioned by the Director in his address the requests for and the giving of advice has now reached an exceedingly high peak and shows signs of increasing further and I also feel that something will have to be done to ensure that both research and advisory services can be continued without detriment to either. Without research there can be no sound advice. In other words an advisory service integrated with the research service but without hindrance to it should be developed.

The industry itself will have to decide whether this will be made possible. On the other hand if such an organisation is not forthcoming it will be necessary to place a limit on Advisory and Research services in order to see that the time of the staff is most usefully and valuably employed to produce a balanced output of investigations and advice based upon it.

It is my last and pleasant duty to express our thanks to the Director, Dr. Young, and staff of the Rubber Research Institute for the excellent arrangements made for today's Conference. The industry requested this conference and I am sure you will agree with me that the Institute's answer to that request is a very satisfactory one.

And finally I would like to thank you all for by presence here today ensuring the success of the conference.

I now declare the proceedings closed and wish you one and all, especially Dr. Newsam of Malaya, a safe return to your respective destinations.

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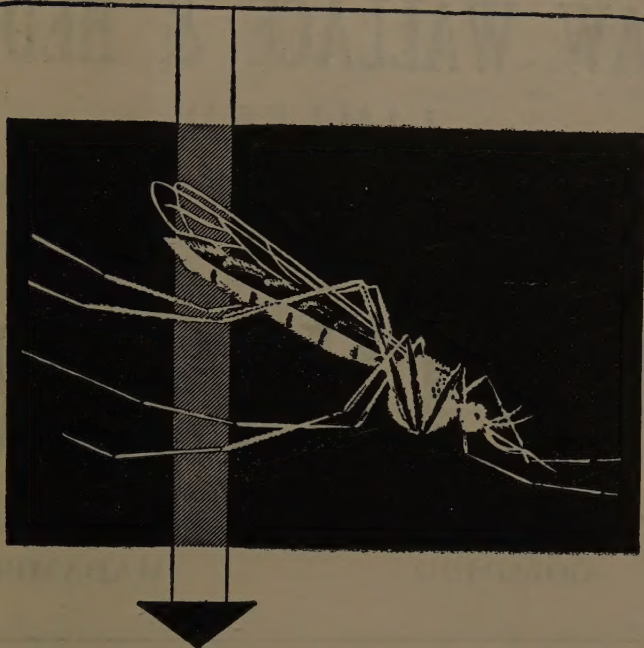

# RUBBER RESEARCH INSTITUTE OF CEYLON

## STAFF

| | |
|---|---|
| **Director** ... | H. E. Young, D.Sc., Agr. (Queensland), A.I.R.I. |
| **Chemistry Department** | |
| Chemist ... | E. J. Risdon, M.A., D.Phil., (Oxon) A.R.I.C., A.I.R.I., |
| Research Assistant ... | M. Nadarajah, B.Sc. (Ceylon) |
| Laboratory Assistants ... | D. S. Muthukuda, M. T. Veerabangsa & G. G. Gnanasegaram |
| **Botany Department** | |
| Botanist ... | C. A. de Silva, B.Sc., (Lond.) C.D.A. (Wye) |
| Research Assistant ... | L. B. Chandrasekera, B.Sc. (Ceylon) |
| Plant Breeder ... | L. Wijeyagunewardene |
| Computer ... | W. G. V. Fernando |
| Laboratory Assistant ... | C. Amaracone |
| **Mycology Department** ... | |
| Mycologist & Oidium Research Officer | Ir. J. H. Van Emden (Wageningen) |
| Asst. Mycologist ... | D. M. Fernando, M.Sc. (Mc.Gill). |
| Laboratory Assistants ... | H. L. Munasinghe & E. G. Mendis |
| **Agronomy Department** | |
| Agronomist ... | D. H. Constable, M.Sc., D.I.C. A.R.C.S. |
| Research Assistant ... | A. J. Jeevaratnam, B.Sc., (Agr.) (Ceylon) |
| Laboratory Assistants ... | T. C. Z. Jayman & M. G. de Silva. |
| **Estate Department** | |
| Superintendent ... | G. W. D. Barnet |
| Officer-in-Charge, Egal Oya Nurseries | H. M. Buultjens |
| Conductors-in-Charge ... | J. Pitchamuthu (Acting) L. P. de Mel & D. C. Kannangara |
| Experimental Conductors (5) | |
| Clerks (4) | |
| Rubber-Maker, Storekeeper, Dispenser, Senior Artisan and Electrician | |
| **Smallholdings Department** | |
| Smallholdings Propaganda Officer ... | W. I. Pieris, B.A. Hortic (C'tab.) |
| Assistant Propaganda Officers ... | N. W. Palihawadana, K. Wilson. de Silva, and H. H. Peiris |
| District Field Officers ... | D. R. Ranwala, P. S. G. Cooray, D. E. A. Abeywickrema and B. D. Pedrick |
| Rubber Instructors (36) | |
| Clerks (4) | |
| **Administration** | |
| Administrative Secretary ... | C. D. de Fonseka, A.C.C.A., A.C.C.S. |
| Chief Clerk ... | B. Tillekeratne |
| Clerks (8) and Clerk-Librarian | |

NOTE: The Laboratories and Head Quarters Offices of the Institute are situated at Dartonfield Estate, Agalawatta, Telephone No. 26 Agalawatta. Telegraphic Address 'Rubrs' Agalawatta. There are two Experimental Stations, one at Nivitigalakele, Matugama and the other at Hedigalla, Latpandura. The office of the Smallholdings Dept. is at Eastern Bank Buildings, Fort, P.O. Box 901, Colombo. Telephone No. 2462 Colombo.

All enquiries and other communications should be addressed to the Director, Rubber Research Institute of Ceylon, Agalawatta.